UNITED STATES DEPARTMENT OF AGRICULTURE
BULLETIN No. 299

Contribution from the Forest Service
HENRY S. GRAVES, Forester

Washington, D. C. PROFESSIONAL PAPER December 13, 1915

THE ASHES: THEIR CHARACTERISTICS AND MANAGEMENT

By

W. D. STERRETT, Forest Examiner, Forest Service

CONTENTS

WASHINGTON
GOVERNMENT PRINTING OFFICE
1915

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By W. D. Sterrett, *Forest Examiner.*

CONTENTS.

IMPORTANCE OF ASH FOR FOREST MANAGEMENT.

The ash genus (*Fraxinus*), containing 18 or more native species, is of considerable importance for forest management in the United States. Because of its fine qualities, which make it valuable in the handle, butter-tub, vehicle, boat-oar, athletic goods, and other industries, and because the supply is limited and the annual output small, ash timber of good grade commands a high price. The tree lends itself readily to both natural and artificial reproduction, has a good rate of growth under proper conditions, responds well to thinnings made to increase its growth, and is comparatively free from destructive attacks of insects and diseases. It is probably more desirable than the other common heavy hardwoods—oak, hickory, maple, birch, and beech—for commercial timber growing on sites to which it is adapted, as it is merchantable when smaller and is usually higher priced and faster growing. It will be one of the first woods the demand for which will exceed the supply. Handle producers as a class feel that they will soon be facing a serious shortage of ash timber, and have as yet been unable to find anything to take its place satisfactorily.

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This bulletin aims to make clear the economic status of ash; to differentiate the species, in regard to which there is considerable confusion, and to indicate their relative importance; to describe the characteristics of the more important species; and to outline methods of forest management for commercial growing of ash timber.

THE LUMBER CUT OF COMMERCIAL SPECIES.

The census returns for the past decade indicate an annual cut of from 200 to 300 million feet of ash lumber, less than 1 per cent of the total cut of all species and between 2½ and 3 per cent of the total cut of hardwoods. In rank in lumber production ash stands twentieth or twenty-first among all species and tenth or eleventh among hardwoods. In addition to the lumber cut the census returns show 25 to 35 million board feet of ash used annually in slack cooperage for staves, heading, and hoops. The total annual cut in lumber and cooperage appears to be about the same as for hickory or for cottonwood. Ash does not figure in the census returns for poles, ties, and other products.

The census figures indicate further that the annual production of ash lumber was maintained or somewhat increased during the decade from 1899 to 1909, but since that time it has considerably decreased. In average f. o. b. value per 1,000 board feet of ash lumber there was an increase of 54 per cent in 1909 over 1899. This increase in price was not maintained during succeeding years, however, which is due largely to an increased proportion of lower grades in the total output. A general survey of the supply of ash timber leads to the conclusion that the high-water mark in the production of ash lumber in the United States, both in quantity and quality of output, has been passed, and it is not likely that either the amount or value of the 1909 cut will ever be equaled.

Another interesting point to be observed in the census figures is the constant shifting in rank of ash-lumber-producing States. In 1899 the cut in Michigan, which was from virgin forests, was greater than in any three other States combined, while in 1911 Michigan had dropped to seventh place, with an output one-sixth as great as that of 1899. Ohio and Indiana, where the cut is practically all from second growth, ranked third and fifth, respectively, in 1909, but rose to first and third places in 1911, although in each case there was considerable decrease in the actual amount of the output. Arkansas, on the other hand, where the cut is from old-growth forest, dropped from first to second place in 1911 and decreased 40 per cent in amount of production from 1909 to 1911. If the production of ash for cooperage stock were added to the lumber cut, however, Arkansas would still be far in the lead. These figures indicate the waning importance of old as compared with second growth. The decline in total production is due to

the impossibility of the second growth's keeping pace with the annual cut, which will be increasingly marked as the supply of old growth disappears.

About 98 per cent of the ash lumber produced in the United States is from the three important commercial species—white (*F. americana*), green (*F. lanceolata*), and black ash (*F. nigra*). The species which make up the remaining 2 per cent of the lumber cut are Oregon (*F. oregona*), blue (*F. quadrangulata*), Biltmore (*F. biltmoreana*), pumpkin (*F. profunda*), and red ash (*F. pennsylvanica*), which all have good silvicultural possibilities. Commercially there are only two kinds of ash lumber recognized—white ash and brown ash—and even these are usually sold together under the common name of ash, because many of the uses to which the lumber is put do not require their separation. The term "green ash" is unknown commercially, and all the lumber cut from this species is marketed as white ash or simply ash.

Tables 1 and 2 show for each species its cut in each ash-producing region of the United States, its proportion of the total cut, and its relative importance in the region. These tables are based on census data for 1910. From these data the cut of ash by counties was determined and careful estimates made by the author of the proportion of each species in each county for which a report was made by the census.

TABLE 1.—*Cut of ash, by regions and species.*

Region.	Per cent of total in United States.	Total cut in region (1,000 board feet).	White ash.[1]		Green ash.[2]		Black ash.	
			1,000 board feet.	Per cent of total in region.	1,000 board feet.	Per cent of total in region.	1,000 board feet.	Per cent of total in region.
New England	5.5	12,965	10,865	83.8	.....	.....	2,100	16.2
Middle Atlantic States	7.4	17,370	13,945	80.3	55	0.3	3,370	19.4
Lake States (Michigan, Wisconsin, Minnesota)	19.3	45,334	13,630	30.1	1,606	3.5	30,098	66.4
Ohio, Indiana, Illinois, West Virginia, Kentucky, Tennessee	32.8	76,927	53,950	70.1	16,437	21.4	6,540	8.5
South Atlantic States and Alabama	5.7	13,307	5,405	40.6	7,902	59.4	.....	.....
Lower Mississippi Valley, including Missouri, Arkansas, Oklahoma, Texas, Louisiana, and Mississippi	28.8	67,678	6,900	10.2	60,778	89.8	.....	.....
Kansas, Nebraska, Iowa, and South Dakota	.2	534	185	34.6	349	65.4	.....	.....
Washington, Oregon, California[3]	.3	600	.....	.....	.....	.....	.....	.....
Total	100	234,715	104,880	44.7	87,177	37.1	42,108	17.9

[1] Includes small per cent of Biltmore and blue ash.
[2] Includes small per cent of pumpkin and red ash.
[3] All Oregon ash.

TABLE 2.—*Distribution by regions of the cut ash of the different species, expressed in per cent of the total cut of each species.*

Region.	White ash.	Green ash.	Black ash.
	Per cent.	*Per cent.*	*Per cent.*
New England	10.4	.....	5
Middle Atlantic States	13.3	0.1	8
Lake States (Michigan, Wisconsin, Minnesota)	13	1.8	71.5
Ohio, Indiana, Illinois, West Virginia, Kentucky, Tennessee	51.4	18.9	15.5
South Atlantic States and Alabama	5.1	9.1	.....
Lower Mississippi Valley, including Missouri, Arkansas, Oklahoma, Texas, Louisiana, and Mississippi	6.6	69.7	.....
Kansas, Nebraska, Iowa, and South Dakota	.2	.4	.....
	100	100	100

In round numbers, white ash comprises 45 per cent, green ash 37 per cent, and black ash 18 per cent of the total output of ash lumber in the United States. The percentage of Oregon ash is insignificant. If the cut of ash for slack cooperage were included, green ash would be just ahead of white ash. These tables show white ash to be the important species in New England, the Middle Atlantic, and the Central States; green ash in the South Atlantic States, the lower Mississippi Valley, and in Iowa, Kansas, Nebraska, and South Dakota; and black ash in the Lake States—Michigan, Wisconsin, and Minnesota. Over half the total supply of white ash comes from the Central States; 70 per cent of the green ash comes from the lower Mississippi Valley, and 71.5 per cent of the black ash from the Lake States. Over 60 per cent of the total supply of ash comes from the Central and lower Mississippi Valley States, 19 per cent from the Lake States, 13 per cent from New England and Middle Atlantic States, and only 5.7 per cent from the South Atlantic States.

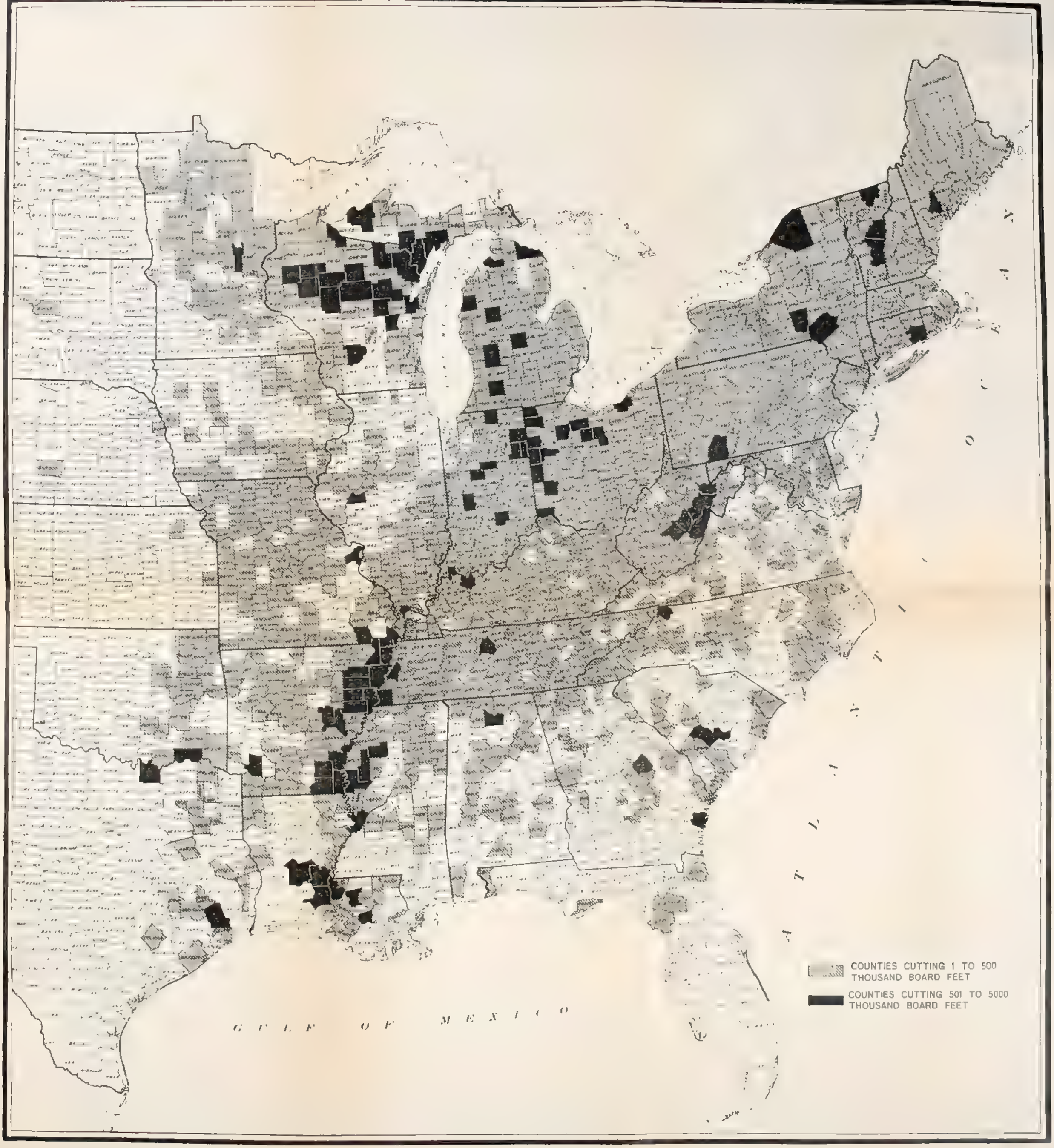
The areas of heaviest lumber production of ash in the United States are indicated by Plate I (map showing the cut of ash by counties for the year 1910.)

CONSUMPTION OF ASH BY WOOD-USING INDUSTRIES AND ITS VALUE FOR DIFFERENT USES.

Practically all of the ash lumber reported by the United States Census is consumed in different wood-using industries. The high value and scarcity of the wood precludes its use in general construction work. Investigations by the Forest Service indicate that a larger amount of ash was used in the wood-manufacturing industries than the census figures report as being manufactured into lumber and cooperage stock. This is probably due to the manufacture of handles, butter tubs, and vehicle stock directly from logs and bolts. In round numbers, 22 per cent of the ash used in industries goes into handles; 20 per cent into butter-tub staves and headings; 15 per

4D

CUT BY COUNTIES



COMMERCIAL DISTRIBUTION OF ASH AS INDICATED BY CENSUS RETURNS OF LUMBER CUT BY COUNTIES IN 1910

cent into vehicles, including automobiles; 7 per cent into planing-mill products; 6 per cent each into furniture, refrigerators and kitchen cabinets, and car construction; 3 per cent each into boxes and crates, agricultural implements, and ships and boats (chiefly oars), and 1 per cent each into fixtures, sporting and athletic goods, musical instruments, machine construction, and hames. It is also used in small quantities for pump sucker rods, tanks, pulleys and conveyers, trunks, printing materials, rollers, elevators, picker sticks, professional and scientific instruments, brushes, patterns and flasks (for foundry work), litters, and airship frames and propellers.

Long handles for shovels, forks, hoes, and rakes of all kinds, short "D" handles for shovels and spades, and boat-hook handles are made almost entirely from ash, as it alone seems to have the proper combination of qualities—straightness of grain, a high degree of stiffness and strength perpendicular to the grain, suitable weight and hardness, and capacity to wear smooth in use. The same qualities make it desirable for agricultural implements, sporting and athletic goods, and boat oars. For making handles, rapid-growing second-growth white and green ash, which yield the strongest and stiffest wood, are the best and the most often used. Old-growth ash is usually considered too fine grained and brittle for handles. All standard baseball bats are made from ash of the strongest second growth. Practically all long oars and sculls (14 feet and over in length) and a large percentage of short oars and paddles are made from ash. For large-sized oars select old growth is much used in order to get the proper size. Black ash as a rule is not suitable for oars, as it will water-soak and become soft and spongy.

About 90 per cent of creamery butter tubs are made from ash, for which it is the most desirable wood because it imparts no disagreeable flavor. For the same reason it is extensively used in refrigerators, kitchen cabinets, and churns. Its wood is very easily worked up into staves and heading for tubs and churns, the supply coming mostly from bottomland green ash of the lower Mississippi Valley. Ash hoops are made mostly from black ash in the Lake States.

In the vehicle and automobile industries strong second-growth white and green ash is used extensively as bentwood for bows, as a substitute for hickory and white oak for tongues, and for single and double trees. Ash is also used for vehicle bodies and panels, for which old growth of all species is preferred, as it can be obtained in greater widths, is not so liable to warp as second growth, and holds glue better.

For planing-mill products, furniture, and car construction old-growth ash is usually preferred because a high degree of strength and stiffness is not required or because large sizes or widths are necessary. Black ash (called brown ash commercially) makes especially handsome interior finish.

Second-growth ash of good quality will usually bring the best price as handle, boat-oar, vehicle, or agricultural-implement stock rather than as lumber. This excludes ash grown in swamps, which is too fine-grained and soft.

Old-growth ash of fair size and quality brings the best price if cut into lumber and graded, the upper grades being sold for car construction, vehicle and automobile bodies and panels, and planing-mill products, the lower grades for furniture, refrigerators, and possibly the cull stuff for butter-tub heading. In exceptional cases high-grade old-growth ash timber can best be sold for boat oars.

Ash timber of poor quality for lumber can probably best be sold for stave and heading bolts for butter tubs or used for firewood or charcoal. It is also used in some parts of the country for fence posts and bars where more suitable kinds of trees are lacking.

Ash timber of old or second growth, suitably located, can often be sold most advantageously for export logs. Five to seven million feet of green ash logs are exported annually in addition to the several million feet of ash exported in the form of deals and planks.

GROUPS AND SPECIES OF AMERICAN ASH.

The ashes in the United States may be divided into five groups, containing in all 18 or more species, distinguished from each other as shown in the key (Table 3).

TABLE 3.—*Key to American ashes.*

Genus FRAXINUS.—Trees and shrubs with opposite, pinnately compound leaves, and fruit a dry samara. Divisible into five groups: *white*, *green*, *water*, *black*, and *shrub* groups, distinguished on the basis of flowers and fruit.

I. Flowers without petals, dicœcious, polygamous, or perfect.

A. Body of fruit terete or nearly so. Wings not extending to base of seed. Bark fissured. Flowers dicœcious.

1. WHITE ASH GROUP. Wings of samara terminal or nearly so.

a. Twigs glabrous.

(1) *F. americana*—seed with wing, 1 to 2 inches long.

(2) *F. texensis*—seed with wing, less than inch long. Hardly more than a form of *F. americana*.

b. Twigs and lower surface of leaflets pubescent.

(3) *F. biltmoreana*.

2. Green Ash Group. Wings of samara decurrent on body of seed to its middle.

a. Twigs, petioles, and pedicels glabrous.

(4) *F. lanceolata* [1]—leaflets 7 to 9 in number, 3 to 6 inches in length, lanceolate to acuminate, and rachis grooved.

(5) *F. berlandieriana*—leaflets 5 to 7 in number, 2 to 6 inches in length, oval or obovate.

b. Twigs, petioles, and pedicels velvety pubescent.

1. Leaflets stalked, subsessile, or sessile—eastern species.

(6) *F. profunda*—samara 2½ to 3 inches long, samara body somewhat compressed, leaflets stalked.

(7) *F. pennsylvanica* [1]—samara 1 to 2 inches long, samara body round and long-linear, leaflets sometimes sessile.

2. Leaflets subsessile or sessile—western species.

(8) *F. oregona*—seed body slightly compressed (Pacific coast tree).

(9) *F. velutina* [2]—seed body round (southwestern tree).

(10) *F. coriacea*—seed body compressed. Thicker, more leathery, longer-stemmed, and broader leaflets than *F. velutina*.

B. Fruit body compressed. Seed kernel long-linear and terete as in green ash. Wings of samara extending to its base and broad. Bark light gray with small, thin, closely appressed scales. Flowers dicœcious.

3. Water Ash Group.

(11) *F. caroliniana*—leaflets 5 to 7, ovate-oblong; fruit elliptical to spatulate, often 3-winged, acute at apex.

(12) *F. pauciflora*—leaflets 3 to 5, oblong; fruit lanceolate to oblanceolate, rounded and emarginate at apex. Hardly more than a form of *F. caroliniana*.

C. Fruit body and seed kernel flat. Wings of samara extending to its base, and broad. Bark gray and scaly. Flowers perfect or polygamous.

4. Black Ash Group.

a. Twigs 4-sided; flowers perfect.

(13) *F. quadrangulata*—5 to 9 leaflets, ovate-oblong to lanceolate, coarsely serrate, rounded or wedge-shaped at base.

(14) *F. anomala*—1 to 3 leaflets (mostly 1); flowers sometimes polygamous.

b. Twigs round; flowers polygamous; northern species.

(15) *F. nigra*—leaflets 5 to 11, oblong-lanceolate, gradually acuminate, laterals being sessile.

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[1] Dr. Britton in his Illustrated Flora (1913 ed.) gives *F. lanceolata* as a pseudonym for *F. pennsylvanica* and gives two other species in this group distinguished from *F. pennsylvanica* as follows:

Wing of samara long-linear..... *F. darlingtonii.*

Wing of samara long-linear spatulate or oblong-spatulate:

Samaras broadly spatulate; leaves firm, entire..... *F. michauxii.*

Samaras narrowly spatulate; leaves thin, serrate, or entire..... *F. pennsylvanica.*

In addition he has *F. campestris*, with lateral leaflets sessile, as a western plains form of *F. pennsylvanica.*

[2] Under this is included *F. toumeyi* (Britton), with leaflets distinctly stalked, a rare form.

II. Flowers with petals, polygamous or perfect—shrubs or small trees of the southwest.

5. Shrub Ash Group.

(16) *F. cuspidata*—panicles terminal on lateral leafy branches of the year; 3 to 7 leaflets, lanceolate and ovate-lanceolate.

(17) *F. greggii*—panicles axillary on branches of the year or previous year; 3 to 7 leaflets, narrowly spatulate to oblong-ovate; petioles wing-margined.

(18) *F. dipetala*—twigs of season's growth 4-angled and smooth; 5 to 9 leaflets, smooth and thick.

The three important commercial species of ash—white, green,[1] and black—occur in different groups, named accordingly. The other two groups, water and shrub ash, contain species of little or no importance for forest purposes. The botanical range of the different species of American ash is shown in Plate II.[2]

The separation into groups is based on differences in flowers and fruits, and further separation into species is chiefly on differences in twigs, leaves, and fruits. Of less importance in identification are bark characteristics and general appearance.

Plate III shows the differences in the seed of different groups, also some of the variations of different species in the same group. The white ash group has the wing of the seed terminal and seed body round and plump. The green ash group has the wing extending along the body of the seed to about its middle, and the seed body round, but slim and long. The water and black ash groups both have the wings extending all around the seed body, the first having a round, slim, long seed kernel, and the second a flattened, broad seed kernel.

Plates IV to VII show differences in leaves and twigs, as well as seed, of the important species of ash. It is important to observe that the last-year's growth on red, Biltmore, pumpkin, and water ashes is pubescent, while that on green, white, and Texan ashes is glabrous.

White and green ash group species have a decidedly fissured bark (Pl. VIII, fig. 1, and Pl. XI, fig. 2) when a foot or more in diameter, while black, blue, and water ash have a scaly bark (Pl. IX). Green ash has finer twigs than white ash, and in the open grows more bushy. Biltmore ash has stouter looking twigs than white ash, and red ash stouter ones than green ash.

In practical identification of ash trees, wherever there is any doubt as to the species, it is well to decide first to which group a tree belongs. The geographic range (see map, Pl. II), habitat, and associated species should be considered. For instance, a swamp ash tree in the Atlantic

[1] Green ash (*F. lanceolata*) is regarded by many as a variety of red ash (*F. pennsylvanica*) on account of the fact that the two forms run together, especially west of the Mississippi. Botanical nomenclature would indicate that the pubescent *F. pennsylvanica* is the important species because named first, but from an economic standpoint it is of very secondary importance to the glabrous form, *F. lanceolata*. In the white ash group the glabrous form, *F. americana*, is economically the important one, but in this case it is also botanically established as the important species.

[2] Prepared by W. H. Lamb of the Forest Service and the author.

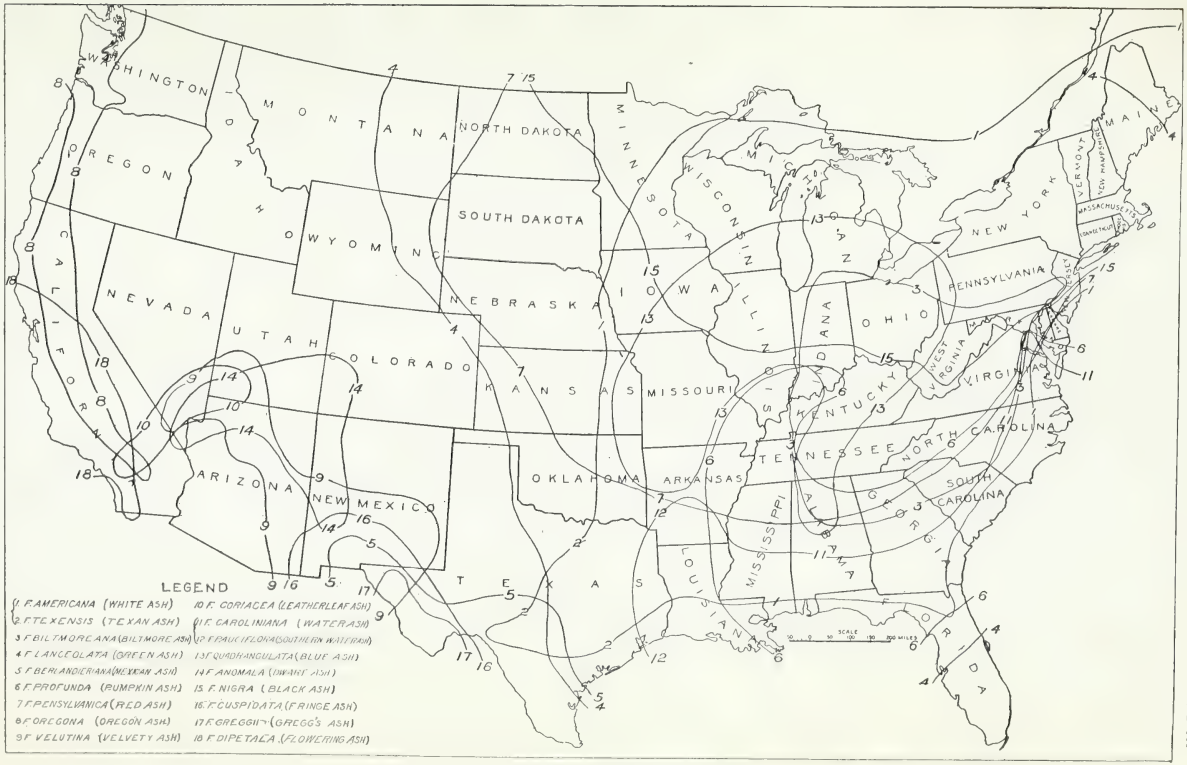
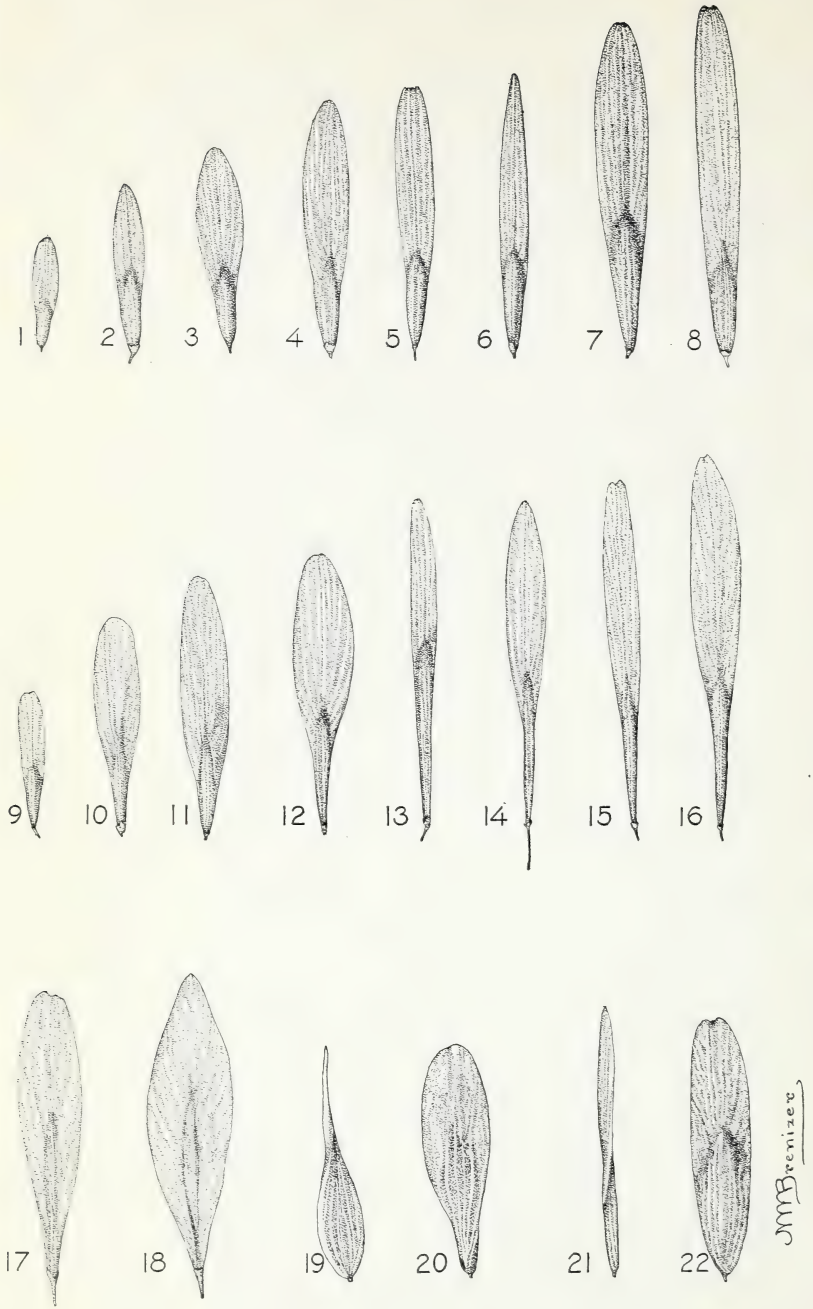


PLATE II.

BOTANICAL RANGE OF AMERICAN ASHES.

The index numbers are the same as used in Tables 3 and 4.



ASH SEED, NATURAL SIZE.

Nos. 1–8, seed of the white ash group: No. 1, *F. texensis;* Nos. 2, 4, and 8, *F. biltmoreana;* Nos. 3, 5, 6, and 7, *F. americana.* Nos. 9–16, seed of the green ash group: No. 12, Britton's *Michauxii;* No. 13, Britton's *F. darlingtonii;* the remainder show variations in size and shape of seed of *F. lanceolata* and *F. pennsylvanica.* Nos. 17–18, seed of the water ash group: No. 17, *F. pauciflora;* No. 18, *F. caroliniana.* Nos. 19–22, seed of the black ash group: Nos. 19–20, profile and face view of a *F. quadrangulata* seed, showing characteristic twist; Nos. 21–22, profile and face view of a *F. nigra* seed, which is characteristically flatter than *F. quadrangulata.*

LEAVES AND SEED OF (*a*) F. BILTMOREANA, (*b*) F. AMERICANA.

LEAVES AND SEED OF (*a*) F. LANCEOLATA, (*b*) F. PENNSYLVANICA.

LEAVES AND SEED OF (*a*) F. CAROLINIANA, (*b*) F. NIGRA, (*c*) F. QUADRANGULATA, (*d*) F. PROFUNDA.

LEAVES AND SEED OF (*a*) F. VELUTINA, (*b*) F. TEXENSIS, (*c*) F. OREGONA, (*d*) F. CORIACEA.

Coastal Plain would likely be *F. caroliniana*, a tree in Oregon or Washington would be *F. oregona*, etc. Where all the necessary botanical characteristics are present identification is easy, but the most important one, seed, is usually absent. This is especially the case with the two most important ashes, white (*F. americana*) and green (*F. lanceolata*), and the groups they represent, both of which, however, are readily distinguished from the black ash group. Where seed is absent it is especially important to consider geographic distribution, site occurrence, and associated species in distinguishing white and green ash. But where both species are found on the same site, as occasionally happens, identification by means of differences in leaves and twigs, bark, and general appearance is the best that can be done. White ash has more robust twigs and buds than green ash, bark usually darker colored, and leaves a darker green color, green ash leaves being more yellowish.

SILVICULTURAL SIGNIFICANCE OF THE GROUPS AND THEIR DISTRIBUTION.

The division into botanical groups also has silvicultural significance. The white ash group is primarily of upland ashes; the green ash group is primarily of bottom-land ashes growing on sites with fair natural drainage during part of the year; the water ash group is of swamp trees; trees of the black ash group occur usually on unfavorable sites, the black ash in cold northern swamps, and the blue ash on dry limestone hills; the shrub group is of chaparral species of the southwest, where climatic conditions are especially severe.

The extent of range and character of distribution of the several groups is influenced to a great degree by reproductive factors, as these determine largely a tree's relative aggressiveness. They include lightness of seed (ease of dissemination), quickness of germination and seedling development, durability of the seed, and frequency of seed years. Climatic, soil, moisture, and light requirements and susceptibility to injury also have considerable influence. All these things vary a great deal in the five groups as a result of the process of adaptation to a wide range of conditions. The green ash group is the most aggressive and widely distributed; the white ash next; and water and black ash groups the least aggressive and the least able to hold their own.

The green ash group has the widest geographical distribution because it seeds most frequently, and has the lightest seed, with the quickest germination—quick to take hold of a favorable opening. (Pumpkin ash is an exception, as it has the heaviest seed of any ash, is not prolific, and has a limited distribution.) The natural local habitat of the green ash group is chiefly moist to wet bottom lands

or the banks of watercourses. The seed is not durable and must find immediately favorable conditions for germination, especially moisture. This group has naturally a better chance of holding its own or even of increasing, like paper birch, through the interference of man, than any of the groups. Since this group has become the most widely distributed, it is natural that it should have produced more species than other groups in adapting itself to varied climatic conditions. The species vary, from those with smooth twigs and leaves, common where climatic or soil conditions are favorable, to very pubescent forms where severe conditions prevail. (See botanical range map, Plate II.)

The white ash group also has a wide geographic range, but less than green ash, because it seeds much less freely; the seeds are as a rule heavier and larger and less easily disseminated, and take much longer to germinate. On the other hand, their seed is more durable, larger kerneled, and stouter, and adapted to somewhat more rugged conditions, so that it has a better chance of germinating and growing than green ash where soil conditions happen to be adverse to immediate growth. Trees of this group occur chiefly on uplands, especially in coves, on moist slopes and depressions, and along upland watercourses.

None of the species in the water or black ash groups have as wide a geographic range as does green or white (see Pl. II), because their seed is heavier and less readily disseminated, and in the case of the black ash group seeding is less frequent. Black ash (*F. nigra*) is the wider distributed of the two and extends farther north than white ash, but not nearly so far south. Certain characteristics of trees of these groups, such as durability of seed of the black ash group and the wide flat wing of the water ash seed which by floating it increases its chance of finding a favorable spot for germination, enable them to perpetuate themselves on unfavorable sites to which they have been relegated by their nonaggressive character. The species of these groups, except blue ash (*F. quadrangulata*), occur chiefly in swamps where conditions are poor for tree reproduction and growth. Blue ash is primarily a tree of rough and dry limestone hills, where conditions for reproduction are also somewhat severe and where acorn and other nut trees are the prevailing growth. These nonaggressive groups are likely to decrease continually in amount and importance.

The shrub group is confined to a very limited area in the Southwest, and may be classified as secondary chaparral species, though not considered desirable even for this kind of forest.[1]

[1] See Forest Service Bulletin No. 85, "Chaparral," by F. G. Plummer.

RELATIVE IMPORTANCE OF THE DIFFERENT SPECIES.

The relative importance for commercial or silvicultural purposes of the different species of American ash is shown in Table 4.

TABLE 4.—*Relative importance of the different species of ash.*

WHITE ASH GROUP.	
1. White ash (*F. americana*)	Commercially and silviculturally the most important American ash. Commercially important east of the Mississippi, except in the Atlantic and Gulf Coastal Plain region. A tree primarily of fertile, moist, upland soils and of coves, and of stream banks where drainage is good.
2. Texan ash (*F. texensis*)	A variety of white ash of no commercial importance, but of some silvicultural possibilities. Occurs on dry limestone bluffs and ridges in northern, central, and western Texas, from Dallas to the Devils River.
3. Biltmore ash (*F. biltmoreana*)	A variety of white ash of some slight commercial importance and with good silvicultural possibilities. Adapted to somewhat drier sites and makes more rapid growth in youth. Chief occurrence in Tennessee, Kentucky, Ohio, and Indiana, especially on limestone formations, at lower elevations than white ash.
GREEN ASH GROUP.	
4. Green ash (*F. lanceolata*)	Commercially and silviculturally nearly equal to white ash in importance. Commercial occurrence limited chiefly to the river bottoms subject to overflow of the Atlantic and Gulf Coastal Plains. Has extended up the Mississippi and its tributaries into Colorado, Wyoming, Montana, Manitoba, and Saskatchewan. The most widely distributed of the ashes.
5. Mexican ash (*F. berlandieriana*).	No commercial importance. Chief occurrence in Mexico. Used for street and plaza planting with good success in cities of the Mexican tableland, but of no importance for the United States.
6. Pumpkin ash (*F. profunda*)	Of some slight commercial importance in river bottoms in southeastern Missouri and eastern and central North Carolina. Found in sloughs with cypress, where it is soft and of very slow growth. On well-drained land more rapid-growing than green ash, especially in youth, and has good silvicultural possibilities. Seed scarce.
7. Red ash (*F. pennsylvanica*)	Of slight commercial importance because too infrequent, but adapted to somewhat drier sites than green ash. West of the Mississippi often not distinguished from green ash.

8. Oregon ash (*F. oregona*).....Of some slight commercial importance in the coast region of the Northwest, on river flats. Occurs from sea level to 3,000 feet elevation, but of merchantable size, usually below 2,000 feet. Occurs in river bottoms and along streams with alder, laurel, maple, walnut, cottonwood, willow, oak, and in the lower limits of Douglas fir forest. It has excellent silvicultural possibilities.
9. Velvety ash (*F. velutina*)....Very slight commercial importance. Good possibilities as a shade and windbreak tree in the arid Southwest, especially if irrigated. Range vicinity limited to the Southwest, along streams.
10. Leatherleaf ash (*F. coriacea*)..No commercial importance. Closely related to *F. velutina*, occurring in the same region, and is adapted to even more severe climatic conditions and suitable for similar uses.

WATER ASH GROUP.

11. Water ash (*F. caroliniana*)...Of very slight commercial or silvicultural importance. Deep river swamps of Atlantic and Gulf Coastal Plains from Virginia to Texas. Trees small and scattering, chiefly under shade of larger trees.
12. Water ash (*F. pauciflora*).....Of very slight commercial or silvicultural importance. Less frequent than *F. caroliniana*. Deep swamps in St. Marys River, Ga., to lower Appalachicola River, Fla. (Sargent).

BLACK ASH GROUP.

13. Blue ash (*F. quadrangulata*)..Commercially of some slight importance, chiefly in the limestone regions of Kentucky, Tennessee, Indiana, and Ohio. Better wood than black ash, and good for planting on dry limestone soils. Not a good reproducer.
14. Single leaf ash (*F. anonola*)..No commercial or silvicultural importance—not much more than a shrub. Grows along streams in arid country—McElmo River, southwestern Colorado, through Utah, to southern Nevada.
15. Black ash (*F. nigra*).....Commercially the third most important ash, but wood inferior to white and green ash. In plantations it grows equally fast. It is primarily a tree of northern swamps, not a good reproducer, and not holding its own in second-growth forests.

SHRUB ASH GROUP.

No commercial or silvicultural importance.

16. *F. cuspidata*.....Rocky slopes and dry ridges, valley of Rio Grande, in Texas and New Mexico, southward into Mexico.
17. *F. greggii*.....Dry limestone cliffs and ledges, valley of Rio Grande, from mouth of San Pedro to that of Pecos River, south into Mexico.

18. *F. dipetala*.....Near foothill streams and in gulches; in dryish or slightly moist rocky and gravelly soils; in clumps mingled with other chaparral species; inner coast ranges and foothills of the Sierra Nevada in California.

OCCURRENCE OF IMPORTANT SPECIES AND THEIR ASSOCIATES.

Ash, with its wide geographic distribution and many different forms and species, naturally occurs on a great variety of sites and in many forest types, but usually forms only a small percentage of the trees of any stand. Exceptions to this are the occurrence of green ash as a principal tree on limited areas of overflow river bottoms of the Mississippi and its tributaries, but usually in comparatively young stands less than 100 years old; of white ash as a principal tree (very rarely) on small areas of second-growth upland hardwood stands on fairly moist soil; and of black ash as occasionally a principal tree in virgin swamp forests of the Lake States. In old-growth virgin stands white and green ash never form more than a small percentage of the merchantable stand, which is mainly of longer-lived, more persistent trees, such as the oaks, birch, beech, sugar maple, yellow poplar, hemlock, white pine, and spruce, red gum, and cypress. Any agency removing the old growth, such as lumbering, often gives white and green ash a chance to become, by their good natural reproduction, relatively more important in the second growth.

WHITE ASH.

White ash occurs on comparatively well-drained sites along small streams, in swales and coves, and on moist north and east slopes, usually where the soil is both moist and permeable. It will grow even in comparatively wet places, provided there is good underdrainage. It occurs in three distinct forest types or associations of trees, in all of which hardwoods predominate: (1) birch-beech-maple-basswood type; (2) mixed oaks and chestnut type; (3) yellow poplar type. In places these types often merge into each other. White ash occurs most frequently in the birch-beech-maple-basswood and the yellow poplar types, where it attains good development and is usually a dominant forest tree. In the mixed oaks and chestnut type it is usually subordinate.

The birch-beech-maple-basswood type is the common northern hardwood forest, which extends south into the Appalachian Mountains at constantly higher elevations to northern Georgia and Alabama. The hardwoods of this type include yellow and black birch, beech, hard and soft maples, basswood, white ash, white elm, bitternut hickory, and black cherry; and in the southern Appalachians, cucumber, yellow buckeye, chestnut, and oaks. Coniferous species

in the type are spruce, hemlock, and white pine, the first two especially on moist situations suitable to white ash. In original forests of this type white ash rarely forms more than from 1 to 5 per cent of the merchantable stand, but in second-growth stands it may form 20 per cent or more.

Sites on which the mixed oak and chestnut type of forest is usually found (exposed upper slopes and ridges and southern slopes) have a comparatively dry, hard soil often thin and very rocky. Such sites are not favorable to white ash, which is fastidious in regard to soil, does not readily develop a rugged, deep-going root system, as do oaks and chestnut, and requires in consequence more surface moisture. On this type white ash usually occurs as a subordinate, overtopped tree of small diameter in comparison with the oaks and chestnut, except for occasional well-developed individuals in depressions where soil and moisture conditions are more favorable. It never forms over 5 per cent of the stand. Ash reproduction takes place readily wherever the cover is slightly broken and at the same time dense enough to preserve good moisture conditions in the humus and soil; but subsequent seedling development is usually poor because conditions are adverse. The mixed oaks and chestnut type is common below 1,000 feet elevation in the glaciated hills of southern New England, southern New York, Pennsylvania, and New Jersey; farther south it occurs at increasing elevations, in the southern Appalachians up to 4,000 feet, mostly on comparatively dry southern slopes and ridges. It is common in southern Michigan, Ohio, Indiana, southern Illinois, Kentucky, and Tennessee, and in the highlands of southern Missouri and northwestern Arkansas. The most frequent associates of white ash on this type are chestnut, red, white, scarlet, black, and chestnut oaks, bitternut and pignut hickories, yellow poplar, red maple, and dogwood; other species sometimes occurring with it are swamp, white, pin, Spanish, black jack, and post oaks, black gum, black walnut, shagbark hickory, ironwood, hornbeam, elm, black cherry, shad bush, sugar maple, sassafras, hemlock, white, pitch, and shortleaf pines, scrub pine, black and yellow birch, paper birch, butternut, black locust, mulberry, beech, and red gum.

The yellow poplar type occurs only on comparatively moist, fertile sites with good drainage, such as in the hollows of small streams, north slopes, and small hollows, coves and swales interspersing drier oak or pine types. In old growth ash forms up to 10 per cent of the stand, and in second growth up to 50 per cent. The yellow poplar type is common from southern New England and southern New York (below 1,000 feet elevation) to northern Florida and west to northern Louisiana and eastern Arkansas and Missouri. Southward it is found at increasing elevations until in the southern Appalachians it reaches 3,500 feet; but it occurs also on moist, well-drained fertile

sites in the Coastal and Gulf Plain region down to elevations of less than 100 feet above sea level. The chief associates of white ash on this type include yellow poplar, red, white, black, pin, and chestnut oaks, black and red gum, pignut and shagbark hickory, black walnut, and chestnut. White ash is very much outgrown by yellow poplar, and often occurs as an overtopped tree in old stands, though in this type it reaches its largest size.

BILTMORE ASH.

The pubescent form of white ash, known as Biltmore ash, is occasionally found in the mixed oaks and chestnut type and in the yellow poplar type of the southern Appalachians and Central States east of the Mississippi River. It is adapted to somewhat drier soil conditions than white ash, and has a more vigorous growth at the outset. In central Tennessee this species sometimes forms from 1 to 5 per cent of the merchantable stand of the original forest.

TEXAN WHITE ASH.

Texan white ash is adapted to dry hills of central Texas, where it occurs with post oak in noncommercial stands.

GREEN ASH.

Green ash is primarily a species of southern overflow river bottoms, most abundant in those of the Mississippi River and its tributaries south of Illinois, also common in other rivers of the Atlantic and Gulf Coastal Plains from Virginia to Texas. It has spread itself extensively along watercourses all over the upper Mississippi Valley north into Manitoba and Saskatchewan and west into Colorado and Montana. In the western and northern limits of its occurrence its place is sometimes taken by red ash, which is better able to survive on upland sites. The bottom land on which it grows is comparatively free from water during most of the growing season at least (Pl. X); it does not flourish like tupelo and cypress on land which is saturated during most of that period, although poor, suppressed specimens of great age are sometimes found on such areas. The characteristic associates of green ash on drier portions of bottom lands, often not subject to overflow, are sweet gum, cottonwood, cow and white oaks, sycamore, white elm, and persimmon; and in the inferior species are hackberry, red and silver maples, boxelder, slippery elm, Kentucky coffeetree, sassafras, dogwood, honey locust, and pawpaw. On intermediate bottom lands, often overflowed but dry during most of the growing season, green ash is characteristically associated with sweet and black gum, cow oak, willow oak, swamp white oak, pecan, hickory, red oak, hackberry, red maple, white elm, cork elm, slippery elm, river birch, willow, mulberry, persimmon, cottonwood, cypress, and tupelo gum; also (of lesser importance) honey locust,

soap berry, dogwood, with a dense undergrowth (in wetter situations) of elbow brush (*Cratægus*), poison ivy, wild grapevine, and wire grasses. Green, pumpkin, and water ashes are often found around the edges of sloughs or back swamps (upon which water stands for from 9 to 12 months in a year) in mixture with cypress and tupelo gum. Green ash is one of the most common species in the very sparsely forested plains and prairie country of the Middle West, growing almost entirely along streams in company with white elm, cottonwood, willow, hackberry, sycamore, black cherry, and bur oak.

RED ASH.

Red ash is a pubescent species of the green ash group occasionally found along streams in the New England, Middle, Lake, and Central States east of the Mississippi River. West of the Mississippi it is often difficult to distinguish from green ash, with which it is apparently connected by intermediate forms.

PUMPKIN ASH.

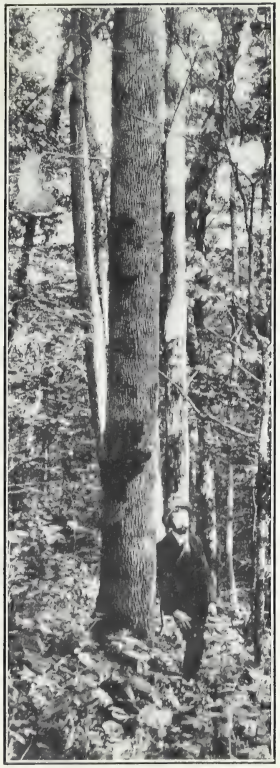
Pumpkin ash is a much more distinct pubescent species of the green-ash group than is red ash, the seeds are much larger, and the tree is more rapid growing in youth under the same conditions. It has a very limited occurrence, however, and is usually found on the wetter parts of overflow river bottoms, unfavorable to rapid development, where it is associated with the same trees as is green ash. It has been observed in commercial quantities only in southeastern Missouri, northeastern Arkansas, and in the eastern half of North Carolina. It may be, geologically, an older species than green ash, but nonaggressive from a reproductive standpoint and relegated to undesirable sites.

OREGON ASH.

Oregon ash occurs along streams, in some cases reaching an elevation of 5,000 feet, though it usually stops at 3,000. It thrives on gravelly flats with the water table near the surface. At low elevations it is associated with maple, oak, and willow. At higher elevations in the oak-digger-pine type and in the Douglas-fir yellow-pine type, its associates are willow, alder, maple, cottonwood, black oak, yellow and digger pine, and Douglas fir. The largest trees and the commercially important stands are in southwestern Oregon, in association with alder, broadleaf maple, and California laurel, on good agricultural soils which are being rapidly cleared for farm land.

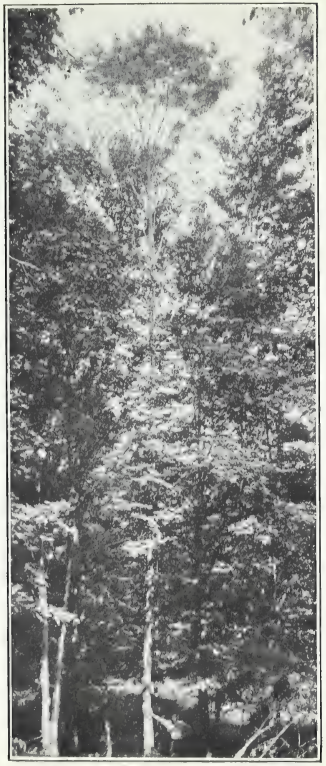
LEATHERLEAF ASH.

F. coriacea is the species commonly named leatherleaf ash, although *F. velutina* is also sometimes so called. The *F. velutina* is the more abundant and occurs chiefly in New Mexico and Arizona, along



F31067

FIG. 1.—Typical long, cylindrical bole of a forest-grown mature white ash in the Southern Appalachians. Characteristically ridged bark.



F12527A

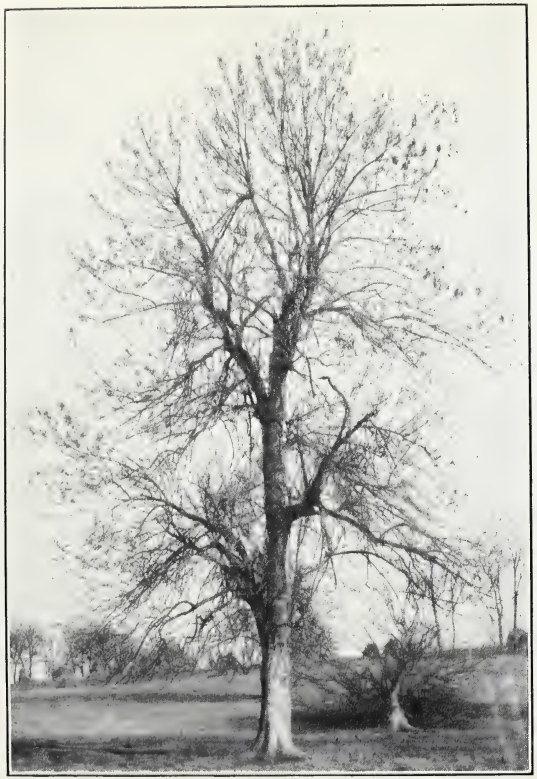
FIG. 2.—Long, slim-bodied, short-crowned, codominant white ash in a crowded stand, 45 years old, 8.2 inches in diameter, 68 feet high, in central New York.

F12528A

FIG. 3.—White ash 60 years old and 80 feet high, originally grown in crowded stand, but subsequently isolated by cutting of other trees. The shorter limbs low down are "water sprouts," which have developed since the stand was opened up 10 years ago.

F13353A

FIG. 4.—Seven-year-old natural Biltmore ash seedling. Shows characteristic opposite branching of ash, and stout twigs characteristic of this particular species.

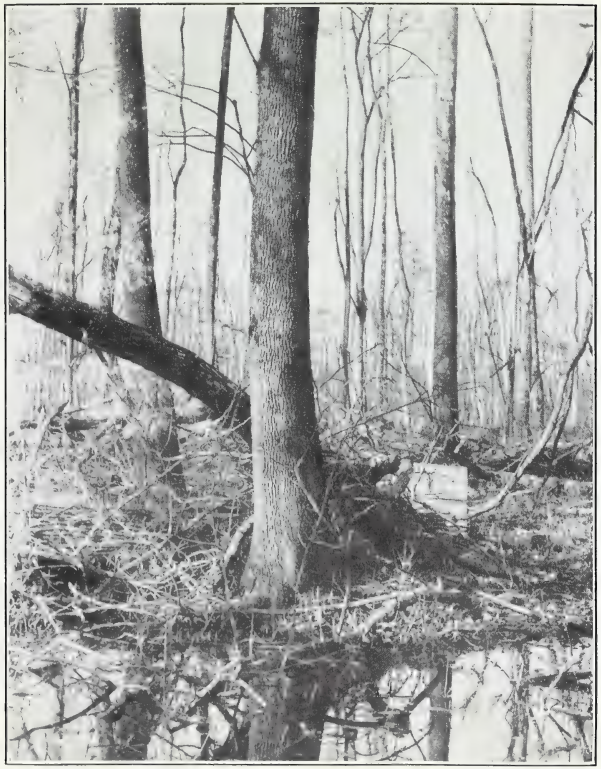


F13924A

FIG. 1.—Typical form of blue ash on pastured limestone uplands in Kentucky, 24 inches in diameter, 75 feet high. Note the very heavy crop of seed on tree.

F19133

FIG. 2.—Black ash pole with characteristic gray, scaly bark. Tree growing in the hemlock-spruce-balsam-birch-maple type.



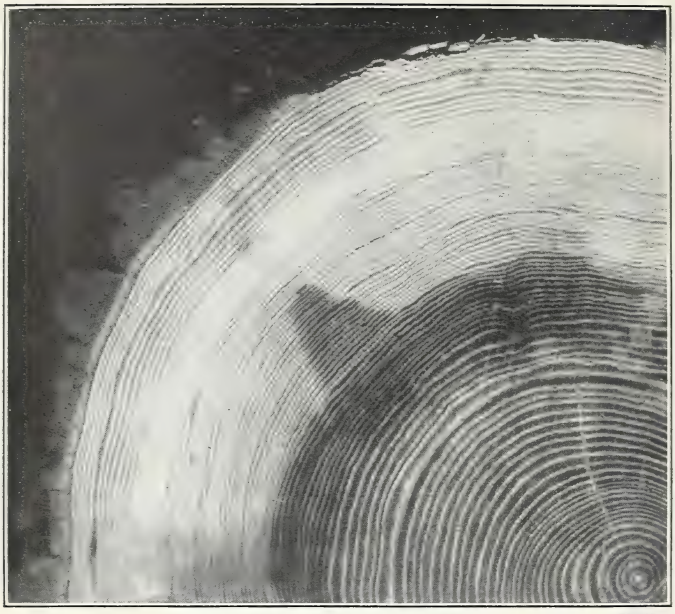
F57816

FIG. 1.—Large pole green ash on bottom land overflowed only at high water. Associated with red gum, red maple, hackberry, and sycamore.

F6823

FIG. 2.—Green ash near edge of slough-bottom type (continuously wet land) in mixture with pumpkin ash and cypress (in the background).

GREEN ASH IN NORTHEASTERN ARKANSAS.



F95257

FIG. 1.—Disk from 85-year-old white ash from clay forest soil in central New York. Shows ability to endure long period of suppression and good recovery after removal of large trees 12 years ago. Note ridged bark and irregular line of heartwood. The slow-growth wood in section is weak and not suitable for handles.

F57835

FIG. 2.—Green ash logs cut on overflow bottom land in northeastern Arkansas, very much checked after lying in the sun several months. Characteristically ridged bark.

streams and canyons from 4,000 to 8,000 feet above sea level, with walnut, cottonwood, boxelder, maple, and sycamore. *F. coriacea* occurs chiefly in desert regions of Nevada and southern California on low mesas (ash meadows) and in canyons; also in southern Utah and northern Arizona.

BLACK ASH.

Black ash is primarily a wet-soil swamp tree of northern lowlands and foothills. Its chief commercial occurrence is in the hemlock type (75 per cent of the merchantable stand being hemlock) of the northern half of the Lake States, where it often forms 5 to 10 per cent of the original merchantable stand, averaging 500 to 1,000 board feet per acre. Single forties may average 2,000 feet of black ash per acre, or about 20 per cent of the merchantable stand, and in very wet places single acres of nearly pure black ash (black-ash swamps) sometimes will cut over 5,000 feet. Associated with the hemlock and black ash on this type are hard maple, yellow birch, basswood, elm, white ash, balsam, spruce, tamarack, and arborvitæ and in the southern part of the Lake States beech, white pine, and soft maple as well. All of these species associate more or less with black ash in the Middle and New England States, where the ash is found chiefly in swamps at an elevation of 500 to 1,500 feet above sea level, but rarely forms more than from 1 to 2 per cent of the merchantable stand. In central Indiana and Ohio its coniferous associates disappear, and it has only an occasional botanical occurrence on wet land with such species as willow, sycamore, soft maple, and pin oak. South of Pennsylvania and Ohio black ash is of no importance whatever, having only an occasional botanical occurrence, chiefly in cold mountain swamps, with balsam, spruce, and hemlock.

BLUE ASH.

This upland form of black ash has adapted itself to dry limestone soils under the shade of oaks and hickories, where moisture, humus, and soil conditions are favorable. It occurs primarily on uplands in the oak type in Ohio, Kentucky, Tennessee, and Indiana.

WATER ASH.

F. caroliniana and *F. pauciflora*.—These are deep-swamp species of the south Atlantic and Gulf Coastal Plain region from Virginia to Texas.

SOIL, MOISTURE, AND LIGHT REQUIREMENTS.

SOIL AND MOISTURE.

Ash as a genus is fastidious and exacting in regard to soil fertility and soil moisture. It is not exacting in regard to atmospheric moisture or the amount of annual rainfall, its chief requirement being a

soil comparatively moist during a considerable part of the growing season. It is exacting in regard to mineral food in the soil and is somewhat exhausting to it. It does well on rich, loose, limy, or marly soils, and some species even on dry limestone soils. It does not do well on binding or argillaceous soils or on dry sand. On porous soils which offer no hindrance to the developing root system it is as a rule less exacting in regard to surface moisture and fertility than it is on stiff impermeable soils. Ash is adapted, some species more than others, for growing in swamps provided the soil is not acid and there is no turf, but it prefers a rich, moist soil which has a rapid renewal of the water through either surface or subterranean drainage.

Although all species of ash thrive best on moist, well-drained, fertile, porous soils, yet the different species vary in their ability to grow on very wet or on dry soils. The important wet-soil species, in the order of their relative capacity for growing on wet sites, are water, black, pumpkin, and green ash, while the species which will endure dryness of soil (east of the Mississippi) are, in the order of relative capacity, blue, Biltmore, and white ash. West of the Mississippi the green ash forms in the fertile prairie and plain States (where red and green ashes run together) are very enduring under dry conditions, as are also the southwestern species of the green ash group.

LIGHT.

Ash is a light-demanding tree, except for the first few years, during which it does best where the soil is shaded. In youth it is more tolerant than oak and reproduces itself well under a comparatively dense forest cover, because this provides, usually, suitable soil-moisture conditions. The seedlings here show great persistence and tenacity and are able to survive for some time. As an underwood in broken forests seedlings thrive well. After the pole stage, however, ash becomes very light-demanding and space-demanding, especially in pure stands, which is a natural result of its wide-spreading, soil-exhausting root system. The relative intolerance of ash is less apparent because it is most often found on moist fertile soils where trees of all kinds have their greatest tolerance. The effects of even slight shading or crowding on the side is at once apparent in long, clear, thin, spindly boles and small crowns. Ash often shows, however, excellent persistence under unfavorable light conditions, although making no substantial growth, and is quick to recuperate and respond to increase in light. The extreme sensitiveness of ash in this respect is one of the things which commend it for forest management.

Blue, black, and white ash are the most tolerant and persistent under adverse light conditions, and green and pumpkin ash the least so.

REPRODUCTION.

Ash reproduces itself well by seed and by sprouting from stumps of trees cut (Pl. XIV), the first, however, being by far the most important in perpetuating the species.

SEED PRODUCTION AND DISSEMINATION.

Ash of any species, in any region where it is common, usually seeds freely about every other year, and bears some seed almost every year. Exceptionally heavy crops occur at intervals of from three to five years. Not all ash trees are capable of bearing seed, since species of the white and green ash groups are dicœcious; that is, male and female flowers are borne on separate trees and seeds occur only on the female trees. Trees in the open are apt to seed when from two to three inches in diameter and from 10 to 20 feet high, being only 10 years old, or even less. In dense stands ash commonly seeds but little until the stand is from 30 to 50 years old and is beginning to thin out. Small-crowned, suppressed, intermediate, and co-dominant trees produce little or no seed; dominant, large-crowned trees and open-grown trees are prolific seeders. Those of the green ash group are the most prolific, seeding when younger and smaller, and more frequently and heavily. White ash is next in this respect and black ash last.

The lightness of ash seed and its long membranous wing allow it to be carried long distances by the wind. Of the important species green ash is disseminated most widely by the wind, white ash is next, and black ash last. The distance depends largely on the weight of the seeds, which is given in Table 5.

TABLE 5.—*Weight of ash seed of different species.*

Species.	Number of seed per pound.			Remarks.
	Low.	High.	Average.	
Fraxinus americana and *F. biltmoreana* [1]	8,500	11,500	10,000	Seed and kernels float in water.
F. lanceolata and *F. pennsylvanica* [2]	12,000	20,000	16,000	
F. nigra, *F. excelsior*, and *F. quadrangulata*	6,000	8,000	7,000	Seed (with wing) floats in water, but kernels sink.
F. velutina			14,000	
F. oregona			10,000	
F. profunda	3,000	4,000	3,500	

[1] Biltmore averages the heavier of the two.
[2] Pennsylvanica averages the heavier of the two.

GERMINATION AND SEED-BED REQUIREMENTS.

There is great variation in the germinative characteristics of the different species of ash. Experiments [1] with good, sound, untreated

[1] Seed planted in flats in the Arlington Experiment Station greenhouse in Jan., 1913.

ash seed planted under favorable conditions gave the following results: (1) Green, red, Oregon, and pumpkin ash seed germinate freely in from four to five weeks; (2) Biltmore ash germinates freely in from six to seven weeks; (3) white ash feebly in five months; (4) black, blue, and European ash [1] not at all the first year. The relative perishability of the seed of these species seems to be inversely proportional to the time required for them to germinate, the green ash group being the most perishable and the black the least. Seed of the black ash type has a germinating period of from one to three years. The white and black ash seed can be made to germinate more rapidly by the method described further on in this bulletin.

Ash seed is especially exacting in its moisture requirements for germination and seedling establishments, and reproduction is restricted to spots where the soil or the humus or leaf litter are liberally supplied with moisture at the proper season of the year. Only a limited amount of light (which need not be direct) is required for reproduction. A moderately open seed bed is sufficient; i. e., a layer of undecomposed leaf litter less than 2 inches thick with humus fairly decomposed beneath. Leaf litter and humus serve to keep the ground moist, but they must not be so thick as to prevent the roots of the recently germinated seedling from coming in contact with the soil.

Ash reproduction is most common where the soil is protected from the drying influences of sun and wind, and where at the same time there is some light to decompose the leaf litter more rapidly than is possible in dense stands; for instance, in small openings in the forest where the light is direct or in pure second-growth white pine stands where considerable indirect light reaches the ground. On large, open areas, bare of protecting leaf litter or shrubby plants and weeds, ash reproduces only along streams and river bottoms and in damp depressions. On uplands reproduction is confined mostly to sites where the soil is well protected.

White ash reproduction is often found in upland forests under shade; even in the mixed oak and chestnut type the species will be found reproducing itself in places where the overhead cover is slightly broken. White ash seedlings are remarkably persistent. They maintain themselves in a stunted condition under the shade of large trees for from 5 to 20 years, dying off almost yearly in the hot part of summer or being eaten off by game or cattle and sprouting again the following season. These are called seedling sprouts. Under favorable soil and moisture conditions in the birch-beech-maple-basswood type and the yellow poplar type ash reproduction

[1] Belongs botanically to the black ash group.

occurs under dense shade; ash seedling sprout root systems 10 to 15 years old are often to be found here. If the large trees are cut, the ash seedlings (or seedling sprouts, as the case may be) will usually grow, but can keep pace with the more rapid growing oak and chestnut sprouts only where soil conditions are exceptionally favorable. Pure second-growth white pine stands form an ideal seed bed for white ash and often abound with ash seedlings and seedling sprouts which furnish an excellent basis for a valuable future admixture of ashes when the crop of mature pine is removed.

In general, natural reproduction of white ash is good—that is, the proportion of white ash increases in second-growth stands following lumbering, especially where clean cutting is practiced. It also seeds in well following fire when seed trees are in the vicinity and are seeding at that time.

Natural reproduction of green ash on river bottom land is also good, and it tends to hold its own or to increase in amount in second-growth stands. Green ash is by far the best species for reproducing on old fields because of its quick germination; it does especially well on moist, old-field bottom land, and on hog-rooted pastures.

Natural reproduction of black ash is not so good; the late germination of the seed makes it more liable to be destroyed and the small amount of seed produced decreases its chances of finding favorable sites for germination.

SEEDLING DEVELOPMENT.

Table 6 indicates the rate of growth of ash seedlings under favorable conditions.

TABLE 6.—*Rate of growth of ash seedlings under different conditions.*

Age.	Height.			
	Green ash on old field, South Carolina bottom land.	Green ash in the forest under half shade, Arkansas bottom land.	White ash in the forest, Ohio under half shade.	White ash clean-cut forest, Massachusetts and New York upland.
Years.	*Feet.*	*Feet.*	*Feet.*	*Feet.*
1	2.8	1.7	0.5	0.5
2	7.0	3.2	1.2	1.6
3	12.2	4.5	2.0	3.0
4	.....	5.7	3.0	4.6
5	.....	6.7	4.0	7.0

A seedling that has existed in suppression for a number of years will usually start to grow, when the forest is opened up, at about the rate given in the table. Seedling sprouts do especially well when

given increased light, and often grow much faster than do ordinary seedlings, because of the large root system they have developed.[1]

Seedlings and seedling sprouts under shade develop slowly. Sometimes the root system is 15 years old and the tree less than 1 foot high. After the first year the seedling demands direct overhead sunlight for best development, but a certain amount of protection on the sides is beneficial.

SPROUT REPRODUCTION.

Ash is a free sprouter from early youth and usually retains its sprouting capacity until old age (see black ash sprouts, Pl. XIV, fig. 2), especially in vigorous trees. The sprouting is both from near the root collar and higher up on the stump. The stump soon decays. Sprouts from near the root collar usually form new roots, and for this reason cutting of low stumps is very desirable in order to limit the reproduction to sprouts of the best kind. It is also a good plan to remove the less vigorous sprouts from a stump in late summer of the first year so as to concentrate the growth into one, two, or three of the more desirable ones.

The vigor of the sprouting increases with the age and size of the tree up to a certain point, after which it falls off. The following measurements [2] on white ash emphasize this point:

Diameter of stump.	Per cent of stumps sprouting.	Basis.
Inches.		*Stumps.*
1 to 4	100	52
5 to 8	100	
9 to 12	83	
13 to 16	80	

White ash sprouts from stumps of healthy trees over 3 inches in diameter grow from 3 to 7 feet the first year, and from 2 to 4 feet a year for several succeeding years. Seedling sprouts, on the other hand (from small seedling root systems), sometimes grow no faster

[1] Measurements by Prof. E. E. Carter in 1912 on two sample plots on the Harvard Forest at Petersham, Mass., gave the following comparative figures on the growth of white ash seedlings and seedling sprouts after clear cuttings in dense mature stands of white pine, under which there was considerable seedling reproduction of ash, ½ foot to 4 feet high, and 5 to 40 years old.

Plot 1.—Seedling sprouts from seedlings cut off at the ground 3 years previously, when the mature stand was cut clean, showed an average total height growth of 4.8 feet in the three years, while seedlings which were not cut back grew only 3.6 feet.

Plot 2.—Seedling sprouts from seedlings cut off at the ground 4 years previously, when the mature stand was cut clean, showed an average total growth of 5.9 feet in the 4 years, while seedlings which were not cut back grew only 4.8 feet.

These plots indicate that cutting off of ash seedlings to facilitate logging operations is beneficial rather than harmful to ash reproduction. The seedling sprouts grew one-third faster than the old seedlings, which means that in addition to straighter stems being produced their chances of getting up out of the reach of browsing stock and deer are much better, which is an important factor in parts of New England and New York.

[2] Measurements taken by J. G. Peters, Hyde Park, N. Y.

when the forest is opened up than do ordinary seedlings; this depends entirely on the relative vigor of their root systems.

Trees of the green ash group are especially vigorous sprouters.

SUSCEPTIBILITY TO INJURY.

STORMS.

Ash is comparatively windfirm under normal conditions, as it develops a wide-spreading, very fibrous, and tenacious root system. Trees of small diameter, with long, slim bodies, left exposed to the sweep of storms after removal of the larger trees, are sometimes uprooted by wind before they have a chance to become windfirm. Also trees located in flood areas of streams are liable to be wind thrown when the soil is badly washed away from around their roots.

The stems of ash trees are strong and elastic and are not subject to windbreak unless infected with heart rot. As the twigs are somewhat brittle, the crowns are sometimes damaged by storms, especially when covered with sleet, but such damage is usually not serious and recovery is rapid.

FROST.

The leaders of ash seedlings growing in the open are sometimes cut back by late spring frosts which follow a growing period of several weeks, but after the trees attain a height of 5 or 6 feet this danger disappears. Ash seedlings readily recuperate from frost damage, but often form double leaders as a result of the injury. Seedlings of American ashes seem to be less subject to frost damage in Europe than native European ash, because they leaf out later. There is considerable variation in earliness of leafing among the different species and among seedlings of the same species grown from seed from different localities. This is important in the culture of ash stands on sites subjected to late frosts. Seeds should be collected, if possible, in the same latitude or to the north of where the planting is to be done.

DROUGHT.

The ashes, except black, pumpkin, and water ashes, offer good resistance to drought when once well established on fertile soils. This is due to their development of numerous long and fibrous lateral roots. Though their rate of growth is very quickly checked by droughty conditions and their leaves soon wither and fall, they live persistently through successive seasons of drought. On the arid plains of western Kansas and Nebraska green ash survived on abandoned timber claims where nearly all other species withered and died. Young ash seedlings are quite susceptible to drought, up to 3 feet high, but by the time they are 5 feet high they have usually developed sufficient root systems to be fairly drought resistant.

Black ash growing in swamps seems to be quickly affected by drainage, and there are large quantities in gradually draining swamps in New York and the Lake States either dead or dying. Excessive transpiration kills these trees down from the top.

In the culture of ash on sites subject to drought, plants from seeds of drought-resisting trees should be used, and the area cultivated for several seasons till good extensive root systems are developed.

ANIMALS.

The tender young shoots and leaves of small ash seedlings and sprouts form unusually attractive browsing for wild animals, especially deer and cattle, which greatly reduces natural reproduction of the genus and causes double leaders on many trees. Trees whose crowns are above browsing distance are practically free from damage by animals.

DISEASES.

Ash is not subject to extensive damage by diseases, which is an important point in its favor. Only one (white rot) has done much serious harm, though a number have been found on the different species. Diseases on ash are confined for the most part to trees whose vitality has been weakened by old age, fire, or generally adverse conditions. Ash stands grown under proper methods of forest management should be practically immune from serious attacks.

White rot occurs in the heartwood of the trunk and main branches, and is caused by the fungus *Polyporus fraxinophilus*, which turns the wood into a mass of yellow pulp. This disease is common in overmature green ash in the lower Ohio and Mississippi River bottoms, near their confluence; also on white ash near the western limit of its range in Iowa, Missouri, Kansas, and Oklahoma, on dry limestone hills, where 90 per cent of the trees are infected.[1] The ash-leaf rust, *Æciduim fraxini*, is probably the most common fungous parasite, occurring on almost all species of ash, but doing little or no serious damage. Other fungi appear on ash leaves and twigs, but rarely in sufficient numbers to do serious injury to the trees affected. Among them are several species of *Glœosporium* and *Sphæropsis*, as well as *Septoria fraxini*, *Phyllosticta fraxini*, and *Sphæronema spina*.

INSECTS.

During the last several years the oyster-shell scale (*Lipidosaphes ulmi*) has increased so much on ash trees in northern Ohio as to kill off entire stands, and is still on the increase in that locality. There are a number of other insects which attack standing ash, but none

[1] Full discussion of this disease in Bulletin No. 32 of the Bureau of Plant Industry, "A Disease of the White Ash caused by Polyporus fraxinophilus."

are very harmful, except the ash-tree borer, which is serious and lessens the value of the wood for lumber.

A large number of insects attack recently felled ash timber. These include a bark beetle, *Hylesinus aculeatus*, which also occurs in dying standing trees; ambrosia beetles or pin borers (*Platypus* and *Xyleborus*); a roundheaded borer, *Neoclytus capria*, destructive to sapwood of recently felled trees; and the powder-post borers, which attack seasoned sapwood. By quick conversion of the felled tree into lumber and by proper methods of handling, seasoning, and storing, losses of logs and lumber through insects can be nearly eliminated.[1]

There should be little or no danger of serious insect attacks on young ash stands under management; nevertheless, the timber owner should be on his guard, and if insects show signs of becoming destructive, he should communicate with the Bureau of Entomology, Department of Agriculture, Washington, D. C., for advice on the subject.

FIRE.

Small ash trees are easily fire-killed because of their thin bark. With increasing size and age ash becomes thicker barked and more fire resistant. Table 24, showing the thickness of bark of trees of different sizes and species, indicates their relative fire resistance (see Appendix, p. 53). Small ground fires, which do not kill standing timber outright, are especially weakening to ash and lessen its rate of growth because of damage to its surface-feeding root systems. It is especially important to keep fire out of young stands.

FORM AND DEVELOPMENT.

Ash is a graceful and beautiful tree, whether growing in the forest or alone as a shade or ornamental tree. Its compound pinnate foliage and symmetrical and regular branching (Pl. VIII) show to advantage in contrast with the foliage and branching of the hardwoods with which it commonly associates.

Ash varies considerably in form and rate of growth in accordance with the character of the site, the amount of growing space, and the species. In general, on favorable sites and under normal forest conditions, dominant ash trees with crowns receiving some direct sunlight on the sides and full light on the tops grow rapidly in both diameter and height, reaching a height of 60 to 80 feet and a diameter of 10 to 20 inches in 40 years. Crowding on the sides, such as codominant and intermediate trees are subjected to, cuts down the rate of diameter growth and increases the clear length, but seems to have little or no effect on the height growth, which persists and is only appreciably lessened by the tree becoming overtopped. In

[1] See Circular 128, Bureau of Entomology, U. S. Dept. of Agriculture: "Insect Injuries to Forest Products."

the open, diameter growth is more rapid, but the tree develops only a very short trunk and large, wide-spreading lateral branches, and is very much inclined to fork, all at the expense of growth in height, and of length, clearness, and cylindricity of bole. Unfavorable sites make themselves at once apparent in a lower rate of height growth in dominant trees. The boles are shorter, more apt to be crooked, and more branchy. In mixed natural stands on such sites ash is usually a spindling, overtopped tree.

In original forests, ashes from 200 to 300 years old, 3 to 5 feet in diameter, and from 125 to 175 feet in height were formerly common, but now 3 feet in diameter is exceedingly large. White ash attains greater height than black or green ash, but is surpassed in diameter and age by black ash. Green ash grows larger in diameter than white ash, but does not become so tall nor live so long.

Crowns of dominant ash trees growing in the forest occupy usually one-third to half the total height of the tree, more on young trees and less on old trees. During the period of rapid height growth, which continues till the tree is from 40 to 60 years old, the crown is rather narrow in proportion to its length and more or less cone shaped; as its age increases it broadens out and becomes dome shaped, and in old age comparatively flat. In youth the crown is considerably longer than it is wide, but this changes with age until the width is greater than the length. Trees crowded on the sides have short, oppressed crowns, often occupying less than a quarter of the total height. (Pl. VIII, fig. 2.)

Ash, because of its intolerance, prunes itself readily when growing in the forest, and develops long, clear, straight boles commonly free of branches for half its total height. The boles have usually a comparatively rapid taper (Tables 25 to 29). Ash trees which have grown under very crowded conditions often have clear lengths of two-thirds or more of their total height.

The species vary somewhat in their characteristic forms as a result of their relative tolerance. Blue (Pl. IX, fig. 1), black, and water ashes have the most persistent limbs and the shortest clear lengths, develop "water sprouts" under lesser light conditions, and for this reason are less desirable to grow (on good sites at least) than white, Biltmore, green, and red ashes.

TABLE 7.—*Rate of growth of white ash on uplands in central New York.*

Age.	A. On moist clay soil.[1]				B. On fresh to moist sandy loam.[2]			
	Fast growth.		Average growth.		Fast growth.		Average growth.	
	Diameter breast-high.	Height.	Diameter breast-high.	Height.	Diameter breast-high.	Height.	Diameter breast-high.	Height.
Years.	*Inches.*	*Feet.*	*Inches.*	*Feet.*	*Inches.*	*Feet.*	*Inches.*	*Feet.*
10	2.1	25	1.3	17	2.5	29	1.3	17
15	3.7	38	2.4	27	5.5	42	3.0	27
20	5.3	50	3.5	36	8.2	52	4.5	34
25	6.7	59	4.5	43	10.4	60	5.9	41
30	8.0	67	5.4	49	12.2	67	7.1	47
35	9.2	73	6.2	55	13.9	71	8.3	53
40	10.2	77	6.9	59	15.3	75	9.4	57
45	11.2	81	7.6	63	16.6	78	10.3	61
50	12.0	83	8.3	66	17.7	79	11.2	65
55	12.9	85	8.9	69	18.7	81	12.2	68
60	13.7	87	9.5	71	19.6	81	13.1	71
65	14.5	88	10.1	73	20.4	82	13.9	74
70	15.2	89	10.6	75	21.2	83	14.8	76
75	16.0	90	11.2	77	22.0	82	15.6	78
80	16.7	92	11.7	79	22.8	83	16.5	81
85	17.3	93	12.2	81	.....	.....	.....	.....
90	17.9	94	12.6	82	.....	.....	.....	.....
95	18.5	95	13.1	83	.....	.....	.....	.....
100	19.1	97	13.6	85	.....	.....	.....	.....

[1] Based on complete analyses of 47 trees, mostly 80 to 100 years old.
[2] Based on complete analyses of 138 trees, mostly 30 to 70 years old.

The root systems of ash are wide-spreading, surface-feeding, very fibrous, and fairly deep-going, those of the more tolerant blue and black ashes being especially deep-going and often developing taproots. Green and pumpkin ashes growing in wet sloughs are usually bell-butted.

The form and volume of ash trees of different species, diameters, and heights are given in Tables 25 to 46 in the Appendix.

RATE OF GROWTH OF COMMERCIAL SPECIES.

WHITE ASH.

Table 7 shows the rate of growth, under favorable natural forest conditions, of second-growth white ash on moist clay upland and on fresh to moist, sandy loam upland in central New York.

Measurements in central New York on second-growth white ash on well-drained, alluvial bottom land, with a moist sandy loam soil, indicate an average rate of growth approximating that of fast growth on upland, sandy loam in the same locality.

The growth of white ash on sandy loam soil averages faster at the outset than on the clay, but it is not so sustained. On the clay site white ash is more tolerant, the stand more crowded, and the growth in diameter of the average tree is necessarily somewhat slower; the better quality of the site, however, is indicated by the greater height attained and by the greater per acre yields. In managed stands of white ash on suitable uplands it would be possible to secure an aver-

age rate of growth in diameter and height nearly equal to that of fast growth under natural forest conditions.

Table 8 shows the rate of growth of white ash under less favorable conditions in southern Indiana.

TABLE 8.—*Rate of growth of white ash on fair upland clay soil in southern Indiana, based on 81 trees 62 to 152 years old.*[1]

Age.	Fast growth.		Average growth.	
	Diameter breast-high.	Height.	Diameter breast-high.	Height.
Years.	*Inches.*	*Feet.*	*Inches.*	*Feet.*
10	1.1	19	0.6	8
20	2.5	34	1.6	17
30	4.1	45	2.5	26
40	5.9	54	3.5	34
50	8.2	62	4.6	41
60	10.9	68	6.0	47
70	14.4	73	7.9	52
80	18.4	78	10.3	57
90	22.8	82	13.2	61

[1] The acceleration in growth at about 50 years is due to a thinning of the forest. Measurements taken by W. Stone in 1909.

Table 9 shows the rate of growth of white ash in natural selection forests containing trees of all ages.

TABLE 9.—*Rate of growth of white ash in natural selection forests, based on 179 trees 77 to 303 years in age, east of the Mississippi River, from Tennessee north.*

Age.	Diameter breast-high.			Height.	
	Maximum.	Average growth.	Fast growth.	Average growth.	Fast growth.
Years.	*Inches.*	*Inches.*	*Inches.*	*Feet.*	*Feet.*
10	2.7	0.6	1.6	8	11
20	6.7	1.8	3.9	14	21
30	11.4	3.1	6.8	21	32
40	16.5	4.4	10.1	27	44
50	20.7	6.0	13.6	35	55
60	24.3	7.7	16.9	43	65
70	27.4	9.5	19.8	52	73
80	30.1	11.4	22.5	60	80
90	32.3	13.2	24.9	67	86
100	34.3	14.9	27.1	74	91
110	36.1	16.7	29.1	80	95
120	.....	18.2	30.9	85	100
130	.....	19.8	32.6	90	103
140	.....	21.2	34.2	94	108
150	.....	22.7	35.7	98	111
160	.....	24.0	.....	101	.....
170	.....	25.4	.....	104	.....
180	.....	26.8	.....	106	.....
190	.....	28.1	.....	109	.....
200	.....	29.4	.....	111	.....
210	.....	30.7	.....	113	.....
220	.....	31.9	.....	114	.....
230	.....	33.1	.....	116	.....
240	.....	34.3	.....	118	.....
250	.....	35.5	.....	119	.....

It will be seen by comparison with Table 7 that the growth is considerably slower than that of comparatively even-aged second-growth with better light conditions. The fast growth in Table 9 about represents the possibilities under proper management.

GREEN ASH.

Tables 10, 11, and 12 show the rate of growth of green ash on bottom lands of North Carolina, South Carolina, and Arkansas to be very rapid and well sustained. The North Carolina table shows slower diameter growth than the South Carolina and Arkansas tables, because the stand where the measurements were taken was a very dense, even-aged, unthinned young stand; the growth in height, however, was rapid enough.

TABLE 10.—*Rate of growth of green ash* [1] *on overflow river bottoms in Orangeburg County, South Carolina, based on 410 trees 32 to 180 years old.*

Age.	Fast growth.		Average growth.		Maximum old field height growth.
	Diameter breast-high.	Height.	Diameter breast-high.	Height.	
Years.	*Feet.*	*Inches.*	*Feet.*	*Inches.*	*Feet.*
5	2.5	23	1.0	15	.....
10	5.3	39	2.4	26	46
15	7.5	49	3.8	34	59
20	9.4	57	4.9	41	71
25	10.2	64	6.0	47	80
30	12.8	69	7.1	52	88
35	14.3	75	8.1	57	95
40	15.7	79	9.1	62	101
45	17.1	83	10.0	66	105
50	18.5	87	11.0	70	110
55	19.8	91	11.9	74	114
60	21.1	95	12.9	78	117
65	22.3	98	13.8	81	120
70	23.5	101	14.7	84	122
75	24.7	104	15.6	88	124
80	25.9	107	16.4	90	125
85	27.1	110	17.3	93	.....
90	28.2	112	18.1	96	.....
95	29.4	115	18.9	98	.....
100	30.5	117	19.7	100	.....
105	31.6	119	20.5	102	.....
110	32.6	121	21.3	104	.....
115	33.7	122	22.1	106	.....
120	34.8	124	22.9	107	.....
125	35.8	126	23.6	108	.....
130	36.9	127	24.4	110	.....
135	.....	129	25.2	111	.....
140	.....	130	26.0	112	.....
145	.....	132	26.7	113	.....
150	.....	133	27.5	114	.....

[1] Measurements taken by K. W. Woodward, 1905.

TABLE 11.—*Rate of growth of green ash* [1] *on old field river bottom land, Iredell County, North Carolina, in a very dense, even-aged, unthinned stand, based on 20 trees 60 years old.*

Age.	Fast growth.		Average growth.	
	Diameter breast-high.	Height.	Diameter breast-high.	Height.
Years.	*Inches.*	*Feet.*	*Inches.*	*Feet.*
10	3.1	32	1.7	25
15	4.7	44	2.7	35
20	6.2	53	3.7	45
25	7.5	61	4.7	53
30	8.7	68	5.6	59
35	9.7	73	6.4	65
40	10.7	78	7.2	69
45	11.6	82	8.1	73
50	12.5	85	8.9	77
55	13.3	87	9.7	80
60	14.1	90	10.5	82

[1] Measurements taken by J. S. Holmes, 1912.

TABLE 12.—*Rate of growth of green ash*[1] *on river bottom land, Mississippi County, Arkansas, based on 394 trees 20 to 160 years old.*

Age.	Fast growth.		Average growth.	
	Diameter breast-high.	Height.	Diameter breast-high.	Height.
Years.	*Inches.*	*Feet.*	*Inches.*	*Feet.*
10	4.0	.....	2.1	14
20	7.8	.....	2.9	31
30	11.4	.....	7.4	45
40	14.6	.....	9.7	57
50	17.4	.....	11.7	67
60	19.9	.....	13.5	76
70	22.1	.....	15.3	85
80	24.2	.....	17.0	92
90	26.2	.....	18.6	99
100	28.1	.....	20.1	105
110	29.9	.....	21.7	111
120	31.7	.....	23.1	117
130	.....	.....	.....	122
140	.....	.....	.....	126
150	.....	.....	.....	130
160	.....	.....	.....	134

[1] Measurements taken by G. M. Homans, 1905.

In growing green ash under management it should be possible to secure an average rate of growth on bottom lands well above the average for growth under natural conditions, but hardly as rapid as the figures for fast growth given in Tables 10 and 12.

On uplands, and farther north and west, the rate of growth of green ash is considerably slower. A green ash plantation on good prairie soil in central Illinois shows an average rate of growth under management no greater than that under natural conditions on southern bottom lands, and in Iowa the growth is still slower. The per acre yield will always be greatest on the well-drained, moist bottom lands of the South, where the greatest density of stand is possible.

Farther west the possibilities of growth are constantly less. The rate of growth in upland plantations in eastern Nebraska is considerably slower than the average for natural bottom land growth in the East.

TABLE 13.—*Diameter and height growth of green ash*[1] *in eastern Nebraska in upland plantations, diameter growth based on 57 trees and height on 216 trees.*

Age.	Average.	Dominant.	Height.
Years.	*Inches.*	*Inches.*	*Feet.*
5	1.1	.....	11
10	2.1	.....	19
15	2.9	3.3	24
20	3.6	4.5	28
25	4.4	5.6	32
30	5.0	6.5	36
35	5.3	7.1	38
40	5.4	7.5	40
45	5.5	.....	41
50	5.6	.....	43

[1] Measurements taken by F. G. Miller, 1905.

In this region the growth falls off rapidly after 25 years, and is not sufficiently sustained to make management profitable. On the better classes of sites, however, with moist soils, especially on bottom land, green ash has a fair chance of profitable growth in the Plains States (Tables 47 to 49). On bottom lands in western Kansas and Nebraska, in young natural stands, green ash has been found to average an inch in diameter growth in three to four years, and in planted stands it grows an inch in diameter every two to three years. In planted stands on uplands in the same region green ash takes five to six years to grow an inch in diameter.

BLACK ASH.

Table 14 shows the rate of growth of black ash in original all-aged selection forests on typical wet land sites in Michigan and Maine.

TABLE 14.—*Rate of growth of black ash in original all-aged selection forests on wet sites.*

Age.	A. In northern Michigan.[1]					B. In Maine.[2]				
	Diameter breasthigh.			Height.		Diameter breasthigh.			Height.	
	Maximum growth.	Average growth.	Fast growth.	Average growth.	Fast growth.	Maximum growth.	Average growth.	Fast growth.	Average growth.	Fast growth.
Years.	*Inches.*	*Inches.*	*Inches.*	*Feet.*	*Feet.*	*Inches.*	*Inches.*	*Inches.*	*Feet.*	*Feet.*
10	1.0	0.4	0.7	9	12	1.8	0.4	1.1	8	15
20	2.4	1.0	1.7	17	24	4.4	1.1	2.7	15	28
30	3.9	1.7	2.7	26	34	7.2	1.9	4.4	22	38
40	5.5	2.5	3.9	34	44	9.9	2.7	6.3	28	45
50	7.3	3.2	5.2	40	52	12.2	3.5	8.1	34	50
60	9.2	4.1	6.5	47	58	14.1	4.4	9.9	38	54
70	11.1	4.9	7.9	52	63	15.7	5.2	11.5	41	58
80	12.9	5.8	9.3	57	67	17.1	6.1	13.1	44	60
90	14.6	6.7	10.7	61	70	18.5	7.0	14.5	47	63
100	16.1	7.6	12.1	64	73	19.8	7.9	15.7	50	65
110	17.6	8.6	13.5	68	76	21.0	8.9	16.9	52	66
120	18.9	9.5	14.7	70	78	.....	9.8	18.1	54	68
130	20.3	10.4	15.9	72	80	.....	10.7	19.3	56	70
140	21.6	11.4	17.1	74	82	.....	11.6	20.5	57	71
150	22.9	12.4	18.2	76	83	.....	12.6	.....	60	.....
160	24.2	13.3	19.3	78	85	.....	13.5	.....	61	.....
170	.....	14.2	20.4	79	86	.....	14.5	.....	63	.....
180	.....	15.1	21.5	81	87	.....	15.5	.....	64	.....
190	.....	16.0	22.5	82	88	.....	16.5	.....	66	.....
200	.....	16.8	23.5	83	89	.....	17.6	.....	67	.....
210	.....	17.6	24.5	84	90	.....	18.7	.....	69	.....
220	.....	18.5	.....	86	.....	.....	19.7	.....	70	.....
230	.....	19.3	.....	87	.....	.....	20.9	.....	72	.....
240	.....	20.1	.....	88	.....	.....	22.1	.....	73	.....
250	.....	20.9	.....	89	.....	.....	23.3	.....	75	.....
260	.....	21.7	.....	90	.....	.....	24.6	.....	76	.....
270	.....	22.5	.....	91	.....	.....	.....	.....	.....	.....
280	.....	23.3	.....	92	.....	.....	.....	.....	.....	.....
290	.....	24.1	.....	92	.....	.....	.....	.....	.....	.....
300	.....	25.0	.....	93	.....	.....	.....	.....	.....	.....

[1] Based on 90 trees 79 to 292 years old. [2] Based on 45 trees 85 to 242 years old.

This growth is much slower than can be expected of second growth on land with fair drainage. Black ash planted on uplands in Illinois has been found to grow as fast or faster than white ash.

OTHER SPECIES.

Limited measurements on the less important species of ash indicate the following points:

Biltmore ash grows as fast or a little faster in youth than white ash on similar sites but is not so long lived.

Pumpkin ash on the same site with green ash grows somewhat faster, during youth at least, but is not so persistent. Red and Oregon ashes grow about the same as green, or a little faster, on similar sites.

Blue ash on upland grows much faster than black ash in its natural swamp habitat and nearly as fast as white ash on the same site with it.

PERIODICITY OF GROWTH.

It has been found in southern Indiana [1] that ash does practically all of its growing during the first part of the season—that is, before the 1st of July—which is probably true generally of the genus throughout its range; the latter half of the season it hardens the wood put on, forms tissues, and stores up energy to be used the next season. These facts indicate the importance of cultivating planted stands during the first part of the season.

COMPARATIVE RATE OF GROWTH OF ASH AND ITS ASSOCIATES.

White and green ashes are comparatively rapid growing on favorable sites but very slow on poor sites. On good land white ash may be ranked after black cherry, yellow poplar, chestnut, and basswood in comparative rate of growth, in the same class with red oak or ahead of it (in youth especially), and ahead of white oak, the hickories, birch, beech, and maple. Green ash on bottom lands in the South with sufficient drainage is less rapid growing than cottonwood, willow, sycamore, and elm but about the same as red gum and the faster-growing red oaks and more rapid than the white oaks, red maple, hickories, black gum, and cypress.

As the prevailing occurrence of black ash is on unfavorable wet soils, its growth is slow but no slower than other northern hardwoods on similar sites.

Pumpkin and water ashes also prevailingly occur on very wet soils, where their growth is slow but not below the average for associated species on that type of land.

Blue ash grows more slowly than walnut and yellow poplar, as fast as the oaks on limestone uplands, and faster than the hickories.

YIELD OF PURE STANDS OF ASH.

Although pure stands of ash are very rare, the only way to get an adequate idea of possible yields per acre under management is by the study of yields per acre of pure stands.

[1] Measurements by Forester Deam, of Indiana, on planted stands of white and green ash.

F12531A

FIG. 1.—Thirty-five-year-old natural second-growth white ash cut for handles.

F4199A

FIG. 2.—Forty-year-old green ash plantation at Champaign, Ill., which will cut 8,000 board feet per acre.

SMALL SECOND-GROWTH ASH VALUABLE FOR HANDLES.

F20793

FIG. 1.—Stand in Indiana 15 years old, trees 3 to 6 inches in diameter and 25 to 35 feet high. Not yet ready for thinning, as natural pruning has not progressed far enough.

F18902A

FIG. 2.—Stand 35 to 40 years old in central Ohio. Trees 6 to 12 inches in diameter and 50 to 60 feet high. Stand will cut 7,000 board feet per acre. Natural pruning has progressed sufficiently to admit of heavy thinning if desired. A slight admixture of other species in the stand, including black cherry, yellow poplar, red oak, and sugar maple. Large tree on left is black cherry, which has considerably outgrown the ash, and tree on right is red oak, which, on the other hand, has been outgrown by the ash.

EVEN-AGED, WELL-STOCKED NATURAL STANDS OF WHITE ASH DESIRABLE TO SECURE IN MANAGEMENT.

Table 15 is the result of tabulating the yields per acre of 63 sample plots in comparatively pure, even-aged stands of ash, half in natural and half in planted stands, from 5 to 75 years old, and drawing three curves to represent high but not the highest (Quality I), average (Quality II), and low (Quality III) yields. The stands represented were mostly on average-quality ash sites. Practically all were unthinned stands, and the yields may be considered as representing conservatively the possibilities of well-stocked ash stands under management on fair to good sites.

TABLE 15.— *Yield of pure, even-aged, well-stocked stands of ash on different quality sites.*[1]

QUALITY I.

Age.	Number of trees per acre 3″ and over.	Average diameter breasthigh 3″ and over.	Yield per acre.		
			Scribner Decimal C		Cords.
			7″ and over.	3″ and over.	
Years.	*Number.*	*Inches.*	*Board feet.*	*Cubic feet.*	
20	427	5.4	2,000	2,200	24.4
25	391	6.5	4,200	3,100	34.4
30	375	7.5	6,500	3,900	43.3
35	361	8.3	9,000	4,600	51.1
40	341	9.1	11,700	5,250	58.3
45	322	9.9	14,700	5,830	64.8
50	288	10.5	18,000	6,350	70.6
55	251	11.2	21,760	6,800	75.6
60	224	11.8	25,700	7,220	80.2
65	203	12.4	29,500	7,600	84.4
70	188	13.0	32,800	7,950	88.3
75	176	13.5	35,600	8,280	92.0
80	166	14.0	38,000	8,600	95.6

QUALITY II.

20	482	4.0	.....	850	9.4
25	435	5.0	1,000	1,680	18.7
30	415	5.8	2,200	2,400	26.7
35	393	6.6	3,600	3,050	33.9
40	378	7.4	5,300	3,630	40.3
45	367	8.0	7,500	4,130	45.9
50	361	8.7	9,900	4,590	51.0
55	350	9.3	12,700	5,000	55.6
60	340	9.8	15,700	5,380	59.8
65	326	10.4	19,100	5,720	66.8
70	309	10.9	22,600	6,010	66.8
75	288	11.5	25,500	6,270	69.7
80	268	12.0	28,000	6,520	72.4

QUALITY III.

25	469	3.5	.....	470	5.2
30	456	4.2	.....	970	10.8
35	452	4.9	300	1,470	16.3
40	426	5.5	1,300	1,950	21.7
45	410	6.2	2,400	2,400	26.7
50	402	6.8	3,900	2,790	31.0
55	392	7.3	5,600	3,150	35.0
60	382	7.9	7,700	3,470	38.6
65	377	8.4	10,200	3,760	41.8
70	371	8.9	12,900	4,020	44.7
75	365	9.3	15,700	4,260	47.3
80	359	9.8	18,000	4,490	49.9

[1] Based on 18 plots, Quality I, 30 plots, Quality II; 14 plots, Quality III, with a total area of 16.9 acres.

The yield table may be considered as especially applicable to pure, even-aged, well-stocked natural stands of white ash, as 42 of the 63 plots were white ash, 28 of which were in natural stands in New York and Ohio. Fourteen plots in planted white ash stands were taken in Illinois, but did not average quite as high yields as those in natural stands farther east.

Fifteen of the plots were in green ash, 14 of which were in planted stands in Iowa and Illinois and 1 in a natural stand in North Carolina. The average yield possibilities for well-stocked stands of green ash on southern bottom lands free from water during most of the growing season would be considerably above that of Quality II in the table, but probably below Quality I.

Six of the plots were in planted black ash stands in Illinois, which indicated higher yields than planted white ash stands in the same State. These yields, however, are very much too high to be representative of the best well-stocked natural black ash stands in typical black ash swamps of the Lake States.

VALUE OF STANDING ASH TIMBER.

A good way to figure the stumpage in any particular locality is to subtract from the f. o. b. mill value of the manufactured lumber the cost of production plus a reasonable profit to the producer for his time, labor, and capital. The total cost of producing ash lumber usually varies from $10 to $18 per thousand board feet, and on the average is not over $14. Ten per cent of the f. o. b. value of the products is enough to allow for profit in figuring what future ash stumpage grown under forest management will be worth. On this basis Table 16 is constructed, giving for different costs of production the value of standing ash timber, which when cut into lumber will sell (mill run) at the prices indicated. The amount of the producer's profit is also given.

TABLE 16.—*Stumpage values per 1,000 board feet for different f. o. b. mill values and different costs of lumbering (allowing 10 per cent for profit).*

F. o. b. value.	10 per cent profit of producer.	Cost of lumbering.				
		$10.	$12.	$14.	$16.	$18.
Per 1,000 board feet.		Stumpage value per 1,000 board feet.				
$20	$2.00	$8.18	$6.18	$4.18	$2.18	$0.18
22	2.20	10.00	8.00	6.00	4.00	2.00
24	2.40	11.82	9.82	7.82	5.82	3.82
26	2.60	13.64	11.64	9.64	7.64	5.64
28	2.80	15.45	13.45	11.45	9.45	7.45
30	3.00	17.27	15.27	13.27	11.27	9.27
32	3.20	19.09	17.09	15.09	13.09	11.09
34	3.40	20.91	18.91	16.91	14.91	12.91
36	3.60	22.73	20.73	18.73	16.73	14.73
38	3.80	24.55	22.55	20.55	18.55	16.55
40	4.00	26.36	24.36	22.36	20.36	18.36

Ash stumpage, especially small second-growth trees conveniently located, will very often be worth more if made into handles (Pl. XII), baseball bats, oars, etc., than if cut into lumber.

From the standpoint of management the value of second-growth stands is the important thing, and this in turn depends largely on the proportion of grades which any particular stand will cut. Table 17 indicates the percentage of the different grades cut from second-growth white ash under 75 years of age of different diameters from comparatively straight and sound trees, such as would be grown in properly managed second-growth stands.[1] The second half of this table shows the f. o. b. mill-run value per thousand board feet of trees of different diameters, taking the following f. o. b. prices for the different grades:

	Firsts and seconds.	No. 1 common.	No. 2 common.	No. 3 common.
High	$60	$35	$25	$15
Average	50	30	20	10
Low	40	25	15	5

TABLE 17.—*Per cent of grades cut from white ash trees of different diameters, for comparatively straight and sound trees under 75 years old, and f. o. b. mill values of the same.*

Diameter breast-high.	Firsts and seconds.	Grade.			F. o. b. mill-value per 1,000 board feet.		
		1 common.	2 common.	3 common.	High.	Average.	Low.
Inches.	*Inches.*	*Per cent.*	*Per cent.*	*Per cent.*			
8	.....	53	34	13	$29.00	$24.00	$19.00
10	1	51	41	7	29.75	24.70	19.65
12	7	47	40	6	31.55	26.20	20.85
14	22	42	30	6	36.30	29.20	24.10
16	29	42	22	7	38.65	32.20	25.75
18	35	39	19	7	40.75	33.70	26.95
20	43	36	15	6	42.75	35.90	28.75

Stated in general terms, the mill-run value of second-growth ash from comparatively straight and sound trees of all three commercial species is about as follows:

Size of trees in diameter, breast-high.	Mill-run value per 1,000 board feet.		
	Low.	Average.	High.
Inches.			
7 to 11	$20	$24	$29
12 to 16	24	29	36
17 to 21	28	34	40

[1] Based on a mill scale study made in western New York of the cut by grades of 43 white ash logs from trees 8 to 20 inches in diameter, breasthigh, and 40 to 70 years old.

Applying the foregoing mill-run or f. o. b. values to Table 16, taking $14 as an average cost of lumbering, would give stumpage values as follows:

Size of trees in diameter, breast-high.	Stumpage value per 1,000 board feet.		
	Low.	Average.	High.
Inches.			
7 to 11	$4.18	$7.82	$12.36
12 to 16	7.82	12.36	18.73
17 to 21	11.45	16.91	22.36

These values may appear too high, because in practice the operator is often at present able to purchase his stumpage for less than its real value and accordingly makes more than 10 per cent profit. This state of affairs, however, is rapidly disappearing as the supply of raw material diminishes; and the operator will finally be forced to do business on less rather than on more than a 10 per cent profit basis, especially when it comes to the purchase of second-growth timber grown at some expense under forest management. Further, it must be remembered that the timber grower is not at the mercy of the market so much as the manufacturer and the farmer, because he can more easily hold his goods until better prices obtain.

Probably a record price for ash stumpage was paid in 1913 in east-central Illinois (near the Indiana line) when $32 per thousand board feet was paid for a quarter million feet of old-growth white ash, while on the same tract, $125 per thousand board feet was paid for black walnut, $24.75 for white oak, and $18.05 for hickory.

ADVISABILITY OF FOREST MANAGEMENT OF ASH.

The growing of ash timber, under proper management, will sometimes pay 6 per cent or better on the money invested, where good yields per acre and good stumpage prices are obtained. This is shown by Table 18, which gives the compound-interest rates (where 3 per cent or over) to be realized on different initial investments in growing ash where the yields indicated in Table 15 are obtained and where the stumpage is worth $5, $10, $15, or $20 per thousand board feet.

TABLE 18.—*Interest rates*[1] *(compound) to be expected on money invested in growing ash, where yield quality I, II, or III stands are secured, calculated for different stumpage values and for different initial investments.*

(Blank spaces indicate less than 3 per cent interest.)

Age of stand.	Value of stumpage per 1,000 board feet.	Total initial investment per acre.																	
		$5.[2]			$10.[3]			$15.[4]			$20.[5]			$25.[6]			$30.[7]		
		Compound interest rates (per cent) for yield quality I, II, and III stands.																	
		I.	II.	III.	I.	II.	III.	I.	II.	III.	I.	II.	III.	I.	II.	III.	I.	II.	III.
Years.																			
20	$5	4.2																	
	10	7.5			3.9														
	15	9.6			5.9			4.3											
	20	11.1			7.3			5.6			4.1			3.3					
30	5	6.1			3.7														
	10	8.8	4.6		6.3			4.9			3.9			3.2					
	15	10.3	6.2		7.8	3.7		6.4			5.4			4.6			4.0		
	20	11.4	7.3		8.8	4.8		7.4	3.5		6.4			5.6			5.0		
40	5	5.8			4.0														
	10	7.9	5.5		6.1	3.7		5.0			4.2			3.6			3.1		
	15	9.1	6.8		7.3	4.9		6.1	3.8		5.4	3.0		4.7			4.3		
	20	10.0	7.7		8.1	5.8		7.0	4.7		6.2	3.9		5.6	3.3		5.1		
50	5	5.3	3.3		3.8														
	10	7.1	5.6		5.6	4.1		4.7			4.1			3.5			3.1		
	15	8.1	6.6	3.9	6.6	5.2		5.7	4.2		5.1	3.6		4.5			4.1		
	20	8.8	7.4	4.9	7.3	5.9	3.4	6.4	4.9		5.7	4.3		5.2	3.7		4.8	3.3	
60	5	4.7	3.0		3.5														
	10	6.4	5.3		5.2	4.1		4.3			3.8			3.2					
	15	7.3	6.2	4.4	6.0	5.0	3.2	5.2	4.1		4.7	3.6		4.2			3.9		
	20	7.8	6.8	5.2	6.6	5.6	4.0	5.8	4.8		5.3	4.3		4.8	3.7		4.6	3.4	
70	5	3.9			3.2														
	10	6.4	4.8		4.6	3.8		3.7			3.3								
	15	6.5	5.7	4.4	5.4	4.7	3.4	4.6	3.8		4.2	3.4		3.7			3.4		
	20	7.0	6.3	5.1	5.9	5.3	4.1	5.2	4.5		4.8	4.0		4.3	3.5		4.0	3.2	
80	5																		
	10	4.8	3.9		3.9	3.0													
	15	5.6	5.0	3.8	4.7	4.1		3.9	3.1		3.5								
	20	6.1	5.7	4.7	5.2	4.7		4.5	3.8		4.1	3.5		3.6			3.4		

[1] Calculated by the formula $p=100\left[\sqrt[n]{\frac{S+L-A}{L+F}}-1\right]$, where p=compound interest rate, n=number of years or rotation, S=stumpage value at n years; L=cost of land; F=cost of formation; and A=cost of administration and taxes in n years at 6 per cent compound interest. Five cents per acre annually is allowed for administration (including fire protection) and one cent on the dollar (full valuation) annually for taxes.

[2] $5 cost of land, and no cost of formation of stand.
[3] $5 cost of land, and $5 cost of formation of stand.
[4] $10 cost of land, and $5 cost of formation of stand.
[5] $10 cost of land, and $10 cost of formation of stand.
[6] $15 cost of land, and $10 cost of formation of stand.
[7] $15 cost of land, and $15 cost of formation of stand.

Where Quality I yields and $20 stumpage are to be obtained, the operator may spend as much as $20 per acre in buying land and establishing a stand of ash and still get 6 per cent interest on the investment. Where Quality II or average yields and $20 stumpage are to be obtained, it is possible to get 6 per cent interest on an investment of $10 per acre. Quality III yields with $20 stumpage will only pay a little over 5 per cent interest on an original investment of $5.

On the average, ash stumpage will be worth only from $10 to $15 per thousand board feet, and well-stocked seedling stands of ash will usually cost $10 or more per acre. On this basis it will require at the least a Quality II yield to pay 6 per cent interest. These figures disregard the possibility of intermediate returns from thinnings, which under especially favorable conditions might amount to from 20 to 30 per cent of the value of the final returns. It may be said in general, however, that growing ash timber as a profitable investment is practically limited to lands which will produce good yields of ash and which do not cost over $10 or $15 per acre.

Ash is one of the most desirable trees for growing in farmers' woodlots, wherever the soil is suitable, because of its usefulness for many purposes on the farm, and because it brings a high price when sold. It is also especially to be recommended for timber growing on agricultural land which the owner does not wish to use or develop at once for agriculture, but which he, nevertheless, desires to hold indefinitely. The cost of growing temporary forest crops which will pay fair returns will be very small in comparison with the cost of developing land agriculturally. Such crops will also require very little supervision. It will often be a wise policy for the farmer to cultivate only so much land as he can handle according to the best farming methods, allowing the rest to grow to timber.

In the management of all forest types in which ash occurs naturally, it is always to be ranked as one of the most, if not the most, desirable species to encourage, often to the extent of securing pure or nearly pure stands of it over limited areas where the soil is suitable.

OBJECT OF MANAGEMENT.

The object of management of ash should be to secure on sites well adapted to its growth either well-stocked, pure, or nearly pure stands; or well-stocked mixed stands of desirable species, ash forming as large a proportion as it is practicable to secure, and being made, by thinnings if necessary, the favored dominant tree with plenty of growing space (Pl. XIII).

Pure stands of ash will usually have to be established by planting or sowing, as only comparatively small patches can be secured by natural reproduction. They should be limited, as a rule, to the best sites and to short rotations, which will insure high yields. On all but the best sites ash is silviculturally better adapted for growing in mixed stands, either singly or in small groups, because the trees are light demanding and develop wide-spreading, surface-feeding root systems, and can be advantageously separated by more tolerant species with deep-growing roots.

ROTATION.

Ash should be grown, as a rule, on comparatively short rotations of 30 to 60 years. Table 18 shows that the best financial rotation, or one which will yield the highest rate of interest on the money invested, falls between these years. The financial rotation is lengthened by low yields, low stumpage values, and high initial investment, while the opposites of these shorten it. The actual rotation in any particular case may be altered from what seems to be the best financial rotation by a number of factors, including the purpose for which the timber is grown, the condition of the market, and the occurrence of seed years.

From a silvicultural standpoint a short rotation is highly advisable for pure even-aged stands of ash, because of the tree's root and crown requirements. Long rotations in pure stands should be practiced only on the best sites, and in some cases where a long rotation is desired the stand should be heavily thinned out and under-planted after it is 40 to 50 years old, to protect the soil. In mixed stands where it is the favored dominant tree ash can often be grown singly or in small groups on a long rotation.

SPECIES FOR COMMERCIAL TIMBER GROWING.

Species of the white and green ash groups are more desirable for commercial timber growing than those of the black ash group, because their wood is superior in mechanical properties and because they are usually faster growing and attain greater length and clearness of bole. There are two classes of sites, however, where for silvicultural reasons it may be advisable to grow ash of the black ash group—namely, blue ash on dry limestone formations of the Central States and black ash in northern swamps.

There is no great variation in the mechanical properties of the different species of the green and white ash groups, and little or none in the sale value of lumber of the same grade from different species, so that the selection of species for commercial growing from these groups depends entirely on their silvicultural qualities. In general, the species which is most common to the region and character of site in question should be used. The growing of species outside their natural habitat (of region and site) should never be tried on more than an experimental scale. White ash will be the species to use, as a rule, in the New England, Middle, Central, and Lake States and in the hills and mountains of the South; and green ash on river bottom land of the Southern, Central, and Plains States. Of very minor importance will be the growing of Oregon ash on the Pacific coast and of leather-leaf ash (*F. velutina*) in the Southwest (the latter for shade, ornament, and protection). Biltmore ash is an important

supplementary species to white ash and can be advantageously substituted for it on drier soils in the Central States and in the southern Appalachians at an elevation of from 1,000 to 2,500 feet. Texas ash is the natural substitute for white ash on uplands in central Texas, but is not important for commercial timber growing. Red and pumpkin ash are two excellent substitutes for green ash, the former adapted to somewhat drier soils and more rigorous climate than green (extending farther north), and the latter to somewhat wetter soil conditions in the central and eastern parts of its range.

Possibilities of reforestation by natural reproduction are quite good with white and green ash, but naturally very limited with the other less abundant species.

In planting or sowing ash it is advisable to use seed from trees of species common in the region (and on similar sites, if possible) where the reforesting is to be done, or from a region with a slightly more rigorous climate. Also seed should always be secured, if possible, from vigorous, rapid-growing individuals.

NATURAL VERSUS ARTIFICIAL REFORESTATION.

Wherever it is possible to secure natural reproduction by using such methods as are described later every effort should be made to do so. Artificial reproduction is more expensive and less certain of ultimate success. Planting should be confined to spots where natural reproduction is incomplete or to areas where there is no possibility of natural growth. It will sometimes be more advisable, however, especially on cheap land, to spend money for disengagement cuttings, to liberate the ash and other desirable species from suppression, rather than for supplementary planting work. In other cases it may be well to divide the money to be spent between planting and disengagement work. In general, the more expensive the land and the higher the stumpage values the more profitable will it be to spend money on artificial reproduction in order to secure fully stocked stands with the largest possible per acre per annum growth instead of being satisfied with incomplete natural reproduction at no expense and giving smaller yields per acre. For instance, Table 18 shows that a 5,000 yield on $20 land with no cost of esablishment will not pay as well as a 10,000 yield on the same with $5 to $15 cost of establishment, while on $5 land a 5,000 yield without cost of establishment would pay best. Similarly the less the natural yield capacity of the soil and the lower the stumpage values the less likely is it to be profitable to spend money in establishing a stand.

Adequate reproduction of ash, resulting in highest yields, demands that on every separate square rod of space there should be at the start a minimum of one thrifty ash seedling, together with at least

three other good seedlings of ash or other species, an absolute minimum of 160 ash trees per acre spaced about a rod apart each way, and a total minimum of 681 trees per acre of all species. This corresponds roughly to a spacing of 8 by 8 feet. For the sake of safety it is best to have two or more ash seedlings on every square rod at the outset. The important point in production of high per acre yields is, not the total number of ash seedlings per acre but the number of individual square rods on the acre which have ash seedlings on them. It is best therefore to plant the square rod areas having no promising natural reproduction of ash on them.

The total area where natural reproduction of ash is possible is very small in comparison with the possible area where it can be artificially established with success, as it very seldom forms a sufficient proportion of the mature stand to reproduce itself adequately. The principal species for natural reproduction are the most abundant ones, which are white, green, and black ash; the other species, where desired will usually have to be artificially established.

REFORESTING BY NATURAL MEANS.

The methods described here apply to all stands, pure or mixed, where the object is to remove the mature stand in such a way as to secure as much natural reproduction of ash as is possible. Methods of cutting (see pp. 42–44) should be used which will bring about the production and dissemination of as much seed as possible over the area, and which will assist in providing suitable seedbed and light conditions for germination and seedling establishment. In many cases additional work may be necessary, such as cutting out worthless material and underbrush to improve conditions for seeding and seedling growth, and later on when the ash seedlings are several years old disengagement cuttings to free them from crowding or suppression. All possible use should be made of seedlings and seedling sprouts already on the ground, as these will usually recover and grow well when the mature stand is opened up. If such growth is scraggly it can be cut back near the ground and allowed to sprout up again, which is especially advisable where it is over 5 feet in height and even in the case of small poles up to 20 feet in height. The mature trees should be cut with low stumps, so as to encourage sprouting from near the ground (below the root collar), which sprouts will form independent root systems and make the best trees.

Any attempt to secure natural reproduction of ash assumes the occurrence, in the stand to be cut, of ash trees which can be used for seeding purposes. It will often be possible to remove the mature stand in such a way as to secure so abundant a reproduction that ash will be one of the leading species in the new stand, though in the

old stand it may form but a very small proportion (Pl. XIV, fig. 1), perhaps only three or four seed trees per acre.

The fact that white and green ash have male and female flowers borne on separate trees will not usually interfere with ash reproduction cuttings, as such cuttings will be made after it is apparent that there is going to be a good seed year, and the tree which will have the most seed can be picked out and reserved. In preliminary reproduction cuttings (to induce seed production) it should be remembered, however, that one large-crowned male tree per acre will pollinate more than enough flowers of female trees on that acre, and the remaining males can be removed if desired. Determination of sex can be made by marking trees which bear seed (female trees) in advance of such cuttings. In mixed stands with a small percentage of ash and where the sexes have not been determined, it will be best to leave all large-crowned ash trees.

METHODS OF CUTTING.

The methods of cutting to secure natural reproduction of ash may be grouped under two general systems; the shelterwood system and the clean-cutting system, the former being adapted to all sites on which ash grows, the latter to a limited range of sites. The best method to use in any particular case depends on a number of factors: The species to be reproduced; the site, especially soil moisture and soil covering; age and density of the stand, including the amount and character of the undergrowth; and proportion of ash in the mature stand.

SHELTERWOOD SYSTEM.

The shelterwood system consists in the more or less gradual removal of the mature stand, allowing reproduction to get well started under the shelter of the mature stand before removing it entirely. This system is especially suitable to upland white ash, as it preserves soil moisture, a liberal amount of which is necessary for germination and seedling establishment. The method of cutting to be used varies with the density of the stand.

In comparatively dense stands the mature trees should be removed in two or three cuttings: First, a seed cutting, often unnecessary, consisting in opening up around ash trees (and trees of other species it is wished to favor) to induce them to seed freely; second, a heavy thinning or partial clearance in the year of good seed production, removing one-quarter to one-half of the volume of the stand; third, removal of the remaining stand a year later or as soon as practicable after reproduction has taken place. Where these cuttings are made with reference to a number of small areas—thinning out around

individual trees or small groups of trees of less than a quarter acre in area—which are gradually enlarged until they meet, it is called the shelterwood group method, and where the general cuttings are made uniformly over a considerable area it is known as shelterwood compartment method. The latter method is suitable for comparatively regular forests, while the former is more applicable to irregular forests, including overmature natural forests, and hence is the one to be most often used under present forest conditions. The compartment system is preferable where possible, because it involves less expensive and complex silvicultural and lumbering operations.

In broken or open stands, where ash seed trees occur with comparatively free crowns, the first and second cuttings may be very much restricted or even omitted altogether. There will usually be, however, in such stands obstructing undergrowth which should be removed when there is a good seed year, preferably cut with a brush hook or bolo in the late summer so as to encourage the feeble growth of tender sprouts which otherwise will likely be winterkilled. The mature stand should be removed as soon as possible after reproduction takes place. Much of the black and blue ash seed will lie over and not germinate till the second year, which may delay removal of the mature stand. Previous to the fall of seed much work can be done in the way of preparation of the seedbed, especially where it is thick and dry: (1) Wounding of the soil in logging operations; (2) burning of the forest floor; (3) turning in stock, especially hogs. This kind of work is not necessary when the cover is prevailingly of pine needles, as ash seed can work its way through (Pl. XIV, fig. 1). If reproduction is inadequate at the first seeding it will not pay (except perhaps with green ash) to wait for another seed year, the area should be cut clean at once and fail spots planted up.

CLEAN-CUTTING SYSTEM.

This consists in clean cutting the stand when there is a good seed year at hand. Seed is secured: (1) By making the cutting after the seed has fallen; (2) by making strip or border cuttings 100 to 200 feet wide on the most protected side of the stand, or by clean cutting in patches 100 to 300 feet wide, so that seed may be secured from trees in the adjacent stand; (3) by clean cutting except for scattered seed trees or groups of trees, several good seed trees or groups to the acre if possible, well distributed. Clean-cutting methods are adapted only to moist or wet loamy soils with an open seedbed. Preparation of the seedbed as described for the shelterwood system will often be advisable. Green ash on southern river bottom lands is especially adaptable to this system, but the other species of ash are much less so.

PLANTING OF FAIL SPOTS AND DISENGAGEMENT CUTTINGS.

A year or two after the seeding of a new crop (simultaneously with the removal of the remaining shelter stand under the shelterwood system, or during the first good season for planting which follows) it is very desirable to go over the stand and plant one or more vigorous young ash seedlings in every square rod which has no reproduction of ash or other desirable species. Some places may be covered with a thick growth of inferior species, in the middle of which a square yard or so is cut clean and an ash seedling planted. Other square rods may be fail spots for reproduction of any kind, and here four (approximately 8 by 8 feet) or more seedlings should be planted, but not necessarily all ash.

Another important thing to be done at the time or within five years (the sooner the better) of the final cutting of the remaining mature stand is disengagement work. This consists in freeing the crowns of a certain number of well-distributed and vigorous ash seedlings (and desirable seedlings of other species) from injurious crowding on the sides and from overhead suppression by lopping off the less desirable seedlings with a corn knife or brush axe. At least one well-freed, vigorous seedling should be left on every square rod, and preferably three or four seedlings of desirable species. One man should be able to cover one or two acres a day in this kind of work.

REFORESTING BY ARTIFICIAL MEANS.

Artificial reforestation of ash is expensive, and should be limited to cleared fields and pastures and to the choicer forest sites in the natural habitat of the particular species to be grown.

There are three general classes of artificial reforesting advisable for ash: (1) Planting on cut-over forest areas (including fail-spot planting in naturally reproduced stands); (2) dibbling in or sowing of ash seed under cover of mature stands (with good soil moisture conditions) to be removed the following year, or sowing immediately after clean cutting of stands on moist, fertile, loamy sites free from undergrowth; (3) planting or sowing of cleared areas, including chiefly old fields and pastures. Underplanting of areas to be cut over later will seldom if ever be advisable.

In regard to the question of planting versus sowing, the former is of much more general application and more certain of success; while the latter is much the cheaper, and under some conditions has good possibilities of success.

PLANTING.

Seedlings for planting should be nursery grown, as a rule, since they are cheaper and much more likely to survive than wild stock. Wild stock seedlings might be used locally to a very limited extent

for filling in spots, when it is not convenient to get nursery stock, and when it is possible to dig them up from near-by spots where they are unnecessarily thick, and to transplant with great care. Wild stock seedlings to be planted in comparatively open spots must be taken from situations with similar shade conditions. Young (1 to 3 years old), vigorous, straight seedlings, under 2 feet in height, should be secured if possible. For nursery-grown stock 1 to 2 year seedlings, 6 inches to 2 feet high, are preferable because cheaper, more easily planted, and usually more likely to succeed than older and larger stock.

The general spacing for plants on cut-over areas has already been referred to (see p. 41). In general, 8 by 8 feet each way will be all right, with every other tree an ash, although on drier and poorer sites 6 by 6 feet should be used. Where there is danger of suppression by undergrowth or natural growth of any kind, vigorous plants 2 to 4 feet high (2 to 3 years old) should be used, but otherwise plants one-half to 2 feet in height (1 to 2 years old) will be sufficient.

In planting fields and pastures the spacing should be 8 by 8 feet where it is possible to cultivate and to grow field crops several seasons between the rows; where not cultivated, 6 by 6 feet spacing (or 5 by 5 if soil is dry) should be used, except on unusually moist fertile soil, where 7 by 7 or 8 by 8 is all right. It is possible to plant as few as one-quarter of the trees ash, and by subsequent favoring to make them form practically a pure stand. In this case every other row could be of another species, and the remaining rows of ash alternating with another species, which would result in the following number of ash trees for the different spacings:

Spacing.	Total plants per acre.	Ash plants per acre (one-quarter of the total.
Feet.		
5 by 5	1,743	436
6 by 6	1,210	303
7 by 7	889	222
8 by 8	681	170

Table 19 gives the species suitable for planting with ash.

TABLE 19.—*Species for planting in mixture with ash.*

Site.	Species of ash to be planted.		
	White ash. Biltmore ash.	Green ash. Red ash.	Black ash.
	Best species to plant in mixture.		
Fresh to dry	Hard maple.[1] White pine.[2] Black locust.[1] Red oak.[2] Beech.[1] European larch.[2]	White pine. Silver maple. Russian mulberry.[1] Red oak.[2] European larch.	
Moist to wet	White pine. Silver maple.[4] Cottonwood.[3] Yellow poplar.[3]	Cottonwood.[3] Willow.[2] Red maple.[1] Loblolly pine.[2] Cypress.[2] Yellow poplar.[3] Pin oak.[2]	White pine. Spruce. Larch. Elm.
Swamp			Spruce.[2] American larch.[2] Elm.

[1] Secondary tree; not liable to overcrowd ash.
[2] Principal tree; not liable to overcrowd ash.
[3] Principal tree; liable to overcrowd ash, and should be sparingly planted and given plenty of room in mixture with ash.
[4] Secondary tree; liable to overcrowd ash and should be thinned out subsequently where necessary, or cut back and allowed to sprout up again.

The general rule should be to cultivate the planted ash stands twice a season for two or three seasons wherever practicable (Pl. XV), except, perhaps, on the best moist, fairly well drained, permeable loamy sites, such as fertile alluvial river bottoms, where the trees will take hold and grow well without cultivation.

COST OF PLANTING.

The cost of planting on unprepared sites, where plowing or cultivation of any kind is impracticable, will range about as follows:

Cost of seedlings (delivered at the site)	$2 to $6, average $4 per 1,000
Cost of setting	3 to 9, average 6 per 1,000
Total	5 to 15, average 10 per 1,000

This is figuring that one man at $1.25 to $2 per day will plant 200 to 400 seedlings per day. Home-grown seedlings could often be produced for less than $2 per 1,000, so $4 for average cost per 1,000 of seedlings is conservative.

Using $10 per 1,000 (a very liberal amount to allow even for cut-over forest land) for cost of plantations, their cost per acre for different spacings would be as given in Table 20.

TABLE 20.—*Cost per acre of establishing ash plantations on unprepared ground with cost of plants $4 per 1,000 and cost of setting at $6 per 1,000.*

Spacing.....feet.	8 by 8.	7 by 7.	6 by 7.	6 by 6.	5 by 5.
Number of plants	681	889	1,038	1,210	1,743
Cost of plants	$2.72	$3.56	$4.15	$4.84	$6.97
Cost of setting	4.09	5.33	6.23	7.26	11.46
Total	7.81	8.89	10.38	12.10	17.43

Wherever possible it is advisable to prepare the land by plowing. The cost of setting the seedlings on prepared ground will be much less—not over $2 to $3 per 1,000—while the growth of the seedlings will be much increased and the number of failures much reduced. The total per acre cost of plantations of different spacings on prepared ground, allowing $2.50 per 1,000 for cost of setting, $4 per 1,000 for the plants, and $1 to $6 for cost of preparation and subsequent cultivations, is shown in Table 21.

TABLE 21.—*Cost per acre of establishing ash plantations on prepared ground with subsequent cultivations, seedlings to cost $4 per 1,000 and $2.50 per 1,000 for setting.*

Spacing.	Number of trees.	Cost per acre of preparation and cultivation.					
		$1	$2	$3	$4	$5	$6
		Total cost of plantation per acre in dollars.					
Feet.							
8 by 8	681	$5.42	$6.42	$7.42	$8.42	$9.42	$10.42
7 by 7	889	6.78	7.78	8.78	9.78	10.78	11.78
6 by 7	1,038	7.75	8.75	9.75	10.75	11.75	12.75
6 by 6	1,210	8.87	9.87	10.87	11.87	12.87	13.87
5 by 5	1,743	12.31	13.31	14.31	14.31	15.31	16.31

The cost of preparation varies from $1 to $3, depending on the care with which it is done and the cost of labor and animals; plowing of wide-spaced furrows without subsequent cultivation can be done for $1 an acre or less.

Two cultivations a season for two seasons will cost 50 cents to $1 per cultivation, or $2 to $4 for the two seasons. All cultivations should be given before the 1st of June, as ash does practically all its growing before the middle of June or the 1st of July. Where the stand is to be cultivated, wider spacing can be used (6 by 6 to 8 by 8) on sites where the dryness of the soil might require closer spacing if not cultivated, a saving in plants and cost of setting which would much more than pay for the costs of cultivation. On the heavy soils of the treeless and hardwood regions cultivation is almost a necessity to keep down grass and conserve moisture.

PLANTING WITH FIELD CROPS.

This is the best of all methods of establishing ash plantations on fields, as it will often be possible, by growing field crops the first two seasons, to pay for the cost of establishing the stand and having it cultivated four or five times in a season. Corn will be the usual crop to grow. The field, after being plowed (preferably the fall before), should be disked and marked off 4 by 4 in early spring, and ash seedlings planted in alternate rows spaced 8 feet apart in the row, and corn planted 4 feet apart in rows with no ash and 8 feet apart in the

rows which contain ash. About four cultivations a year will usually be necessary for growing corn. Instead of planting ash seedlings, seed spotting may sometimes be used on better sites in connection with field crops.

On the Indiana State Forest, a 3-year plantation of green ash on upland, in which corn was grown the first two seasons, averaged a foot higher and was in much thriftier condition for more rapid growth than a 6-year old plantation on slightly better soil but not cultivated.

DIRECT SOWING.

The comparative cheapness of direct sowing makes it sometimes advisable, instead of planting, where there are good chances of success. The seed-spot method is the one to use: (1) For dibbling in seed under the broken cover of a mature stand to be cut in a year or two, with fair soil moisture conditions; (2) for sowing on cut-over areas free from undergrowth immediately following clean cutting of the mature stand, on good moist loamy soil; and (3) for sowing on cleared land, such as pastures, which it is not possible to prepare by ploughing. A pound to two pounds of seed will easily sow an acre, allowing 5 to 10 seed per spot and a close 4 by 4-foot spacing of spots, which is advisable in direct sowing. The holes should be dug 8 to 12 inches square and 3 to 4 inches deep (with a mattock or heavy turfing hoe), the soil broken up fine and lightly tamped down, the seed put in and half an inch of fine earth sprinkled over it. If there is any sod this can be placed, grass side down, around the edge of the hole so as form a sort of trench to hold moisture. The cost of seed-spotting, including seed, should not average over $4 per 1,000 spots, which is equivalent to $10.89 per acre for 4 by 4 spacing, $6.97 for 5 by 5 spacing, $4.84 for 6 by 6 spacing, $3.56 for 7 by 7 spacing, and $2.72 for 8 by 8 spacing.

Methods to use on prepared ground are: (1) Ploughing area, broadcasting 3 to 4 pounds of seed per acre, and harrowing it in; (2) seed-spotting at 4 to 6 foot intervals in ploughed furrows 4 to 6 feet apart. The total per acre cost would be about the same in both cases, $5 to $10 per acre.

THINNINGS.

Thinnings in crowded stands should be made an important feature in the management of ash (Pl. XIII). It is an intolerant but persistent tree, developing very rapidly in height, when crowded, at expense of diameter growth, resulting in spindling trees with short narrow crowns and long slim boles (Pl. VIII, fig. 2). It is, however, very responsive to thinnings made to increase its diameter growth (Pl. XI, fig. 1).

F11240A

FIG. 1.—Dense natural reproduction of white ash in a 60-year-old white pine stand heavily thinned 3 years ago, in which there was a slight admixture of white ash seed trees. There was also abundant white pine reproduction, but this has been outgrown by the ash. In removal of the mature stand the ash reproduction should be preserved and the pines, which survive the suppression, allowed to continue as an understory till the ash becomes merchantable and is removed, when the pine will form a second crop.

F13351A

FIG. 2.—Black ash sprouts, northern Michigan, 16 feet tall, 8 years old, from stump 230 years old. Some sprouts from above and below the root-collar; the former should be cut.

REPRODUCTION OF ASH.

FI3352A

FIG. 1.—Green and red ash, 8 to 20 feet, average 13 feet high; planted 5 seasons ago, spaced 5 by 5 feet; one-year seedlings used and cultivated 2 seasons. The tallest trees with stoutest twigs are red ash, which bore seed the fourth season after planting.

FI3354A

FIG. 2.—Green ash 2 to 6 feet, average 3½ feet high, near those in figure 1. One-year seedlings planted with iron spud 6 seasons ago but not cultivated.

ASH PLANTATIONS IN THE INDIANA STATE FOREST.

F12817A

FIG. 1.—Before thinning, crowns were crowded.

F12818A

FIG. 2.—After thinning, crowns were free. Crowns should be at least this distance apart after thinning to secure good development of the trees left.

LOOKING UP INTO THE CROWNS OF A TWENTY-YEAR-OLD WHITE ASH STAND.

The comparative growth of trees with varying amounts of growing space is shown in Table 22, giving the growth in 10 years of different crown classes;[1] predominant, dominant, codominant, intermediate, and suppressed. By thinning it is possible to make dominant trees out of desirable codominant and intermediate ones which are being crowded by less desirable trees, especially of other species.

By thinnings it should be possible in some cases to secure the board-feet yields indicated in Table 18 from 5 to 10 years earlier, and increase accordingly the possible interest rate on the money invested, provided the thinnings can be made to pay for themselves.

Very slight crowding of ash when comparatively young will develop long, straight, clear boles. As soon as these are established it is best, in order to get the most valuable development of the stand, to thin out so that each tree which is to form a part of the final crop will have its crown practically free on all sides (Pl. XVI). It will usually be sufficient for purposes of heavy thinning if the boles are clear for 25 feet or more from the ground, or if the branches are all dead up to that height.

TABLE 22.—*Relation of crown class, age and size of trees, and size of crown, to rate of growth in diameter and volume of white ash in New York, growing in comparatively even-aged dense stands.*

TREES ON SANDY LOAM SOIL, OSWEGO COUNTY, NEW YORK.

Crown class.	Average.			Average crown.			Growth in last 10 years.		
	Age.	Diameter breast-high.	Height.	Length.	Width.	Branchwood 2 inches or more in diameter.	In diameter.	In volume of stemwood inside bark.	Basis.
	Years.	*Inches.*	*Feet.*	*Feet.*	*Feet.*	*Cu. ft.*	*Inches.*	*Cu. ft.*	*Trees.*
Suppressed	32	4.1	45.1	17.2	10.6	.....	1.1	1.02	8
Dominant	41	11.3	67.1	28.1	19.8	2.16	3.2	10.00	31
Codominant	41	9.2	65.9	23.8	16.3	.72	2.3	6.31	41
Intermediate	40	7.0	57.9	22.8	13.4	.05	1.3	2.65	16
Predominant	60	17.4	68.7	40.1	29.2	10.88	2.7	15.41	7
Dominant	60	15.7	77.9	33.7	23.2	4.72	2.7	14.76	17
Codominant	60	12.4	74.9	27.9	17.7	1.57	1.8	7.94	15
Intermediate	60	9.1	69.3	24.6	16.0	.77	1.3	3.98	6
Predominant	85	19.1	90.9	33.7	30.3	8.78	4.5	30.30	3

[1] Under predominant, dominant, and codominant are included all trees which go to form the upper or main crown cover: (1) predominant, trees with crowns well above those of other trees; (2) dominant, trees with well-formed crowns, receiving light on all sides; (3) codominant, trees with uneven crowns and crowded on the sides. The intermediate and suppressed classes include overtopped trees below the upper crown cover; (4) intermediate, receiving some direct sunlight on tips of crowns; (5) suppressed, with tips of crowns shaded.

TABLE 22.—*Relation of crown class, age and size of trees, and size of crown, to rate of growth in diameter and volume of white ash in New York, growing in comparatively even-aged dense stands*—Continued.

TREES ON CLAY SOIL, OTSEGO COUNTY, NEW YORK.

Crown class.	Average.			Average crown.			Growth in last 10 years.		
	Age.	Diameter breast-high.	Height.	Length.	Width.	Branchwood 2 inches or more in diameter.	In diameter.	In volume of stemwood inside bark.	Basis.
	Years.	*Inches.*	*Feet.*	*Feet.*	*Feet.*	*Cu. ft.*	*Inches.*	*Cu. ft.*	*Trees.*
Suppressed	66	7.0	68.1	12.0	13.0	.....	1.2	2.62	1
Dominant	75	13.6	83.6	29.3	20.1	2.57	2.0	9.68	7
Codominant	76	12.5	85.5	24.4	15.7	1.83	1.3	6.96	8
Intermediate	76	9.7	77.9	22.1	12.4	.54	1.0	4.09	4
Predominant	105	19.7	94.6	40.0	24.0	9.50	2.1	16.33	1
Dominant	105	15.8	89.9	28.7	18.7	4.32	1.4	9.44	10
Codominant	105	12.5	83.4	20.1	14.2	1.44	.7	3.95	8
Intermediate	104	11.6	80.3	26.5	14.5	1.50	1.0	4.38	2
Suppressed	106	9.6	78.3	30.5	13.0	.38	1.2	4.24	2

Liberal growing space for crowns is especially important for ash over 35 years old, to enable it to lay on diameter growth. In general, however, trees in stands under 35 years of age should be kept slightly crowded, being given a medium to heavy underthinning every five to ten years, preferably commencing when the stand is 15 to 20 years old. When 35 to 40 years old the stand should be heavily thinned, amounting to a partial clearance on good sites, and the crowns of the remaining trees left free on all sides.

Ash on poorer sites is more intolerant and natural thinning more rapid than on good sites; so that the better the site the more important it is to thin and the greater the yield from thinnings. Figures on the rate of growth of individual trees on sandy and clay soils in New York (see Table 7) show faster growth in diameter and volume during youth on the poorer sandy site, while the reverse would have been the case if the stand on the better clay site had been thinned. In unthinned stands of ash under 50 years of age, the board foot yield and stumpage value per acre may be actually greater on a poorer site because of more rapid natural thinning and higher average diameters, although the total yield in cubic feet, number of trees per acre and height of stand is always greater on the better sites; this emphasizes the importance of thinnings in ash stands on good sites to concentrate the diameter growth into a smaller number of trees.

Money returns from thinning ash stands are already a possibility in some parts of the country, and as the supply of ash decreases thinnings will become more and more profitable. The yield from thinnings in some cases can be expected to equal 20 per cent or more of the returns from final cuttings of mature stands.

SUMMARY OF SPECIES OF ASH FOR MANAGEMENT.

The species of ash suited for forest management on different sites and in different regions of the United States and methods of reforestation to be used are summarized in Table 23.

TABLE 23.—*Summary of species for management in different regions.*

Region and character of site.	Species to use in order of preference.	Possibility and method of natural reproduction.	Artificial reforestation.
(1) New England, Middle, and Lake States:			
Dry upland (especially south and west slopes).	Blue ash, on rich soils only; experimental.	Poor; shelterwood system; dibbling in seed.	Planting of 2-foot seedlings, spaced 4 by 4 to 6 by 6 feet; cultivation for 2 years essential; preferably mixed plantations.
Fresh to moist upland (especially north and east slopes).	White ash, and experimentally Biltmore ash.	Fair; shelterwood system; dibbling in seed.	Planting 6 by 6, or 8 by 8 if cultivated two seasons; cultivation advisable.
Bottomland with fair surface or under drainage.	White ash, red ash, black ash.	Good; clear cutting; seed dibbling.	Planting 8 by 8, or seed spots. Subsequent thinnings.
Swamp	Black ash	Fair; clear cutting; seed dibbling.	Planting of seedlings 6 by 6 feet.
(2) Central States, Southern Appalachians and Piedmont regions:			
Dry upland (especially south and west slopes).	Blue and Biltmore ashes; on rich soils only.	Poor; shelterwood system; dibbling in seed.	Planting 2-foot seedlings, 4 by 4 to 6 by 6 feet; 2 years cultivation; mixed plantations best.
Fresh to moist upland (especially north and east slopes).	White and Biltmore ashes.	Fair	Planting 6 by 6 or 8 by 8 if cultivated two seasons; cultivation advisable.
Bottomland with fair surface or underdrainage.	White and green ashes.	Good; clear cutting.	Planting, 8 by 8, or seed spots. Subsequent thinnings.
Swamp	Black, pumpkin, and green ashes.	Fair to poor; clear cutting; seed dibbling.	Planting of seedlings 6 by 6 feet.
(3) Atlantic and Gulf Coastal Plain region:			
Fair surface or subsurface drainage.	Green and pumpkin ashes.	Good; shelterwood and clear-cutting methods; seed dibbling.	Planting 6 by 6 to 8 by 8 or seed spots. Subsequent thinnings.
Swamp	Pumpkin and green ashes.	Fair to poor; clean cutting; seed dibbling.	Planting 6 by 6.
(4) Prairie and Plains States:			
Upland	Red and green ashes.	Poor	Planting 6 by 6 and cultivated two to four seasons.
Bottom land	Green and red ashes.	Fair	Planting 6 by 6 to 8 by 8 and cultivated.
(5) Pacific Coast region:			
River flats	Oregon ash	Fair; clear cutting and shelterwood systems.	Planting 6 by 6.
(6) Southwest:			
Canyons	Leatherleaf ashes (*F. velutina* and *coriacea*.)	Poor; shelterwood system.	Planting 6 by 6. Hardly to be advised.
Irrigated land	do		Planting, irrigation, and cultivation four seasons. For shade trees and windbreaks only.

APPENDIX.

TABLES.

BARK TABLE.

Table 24—Double width of bark of white, green, and black ash.

FORM TABLES.

Tables 25 and 26—White ash form tables:
- Table 25—For trees under 75 years in age.
- Table 26—For trees over 75 years in age.

Tables 27 to 29—Green ash form tables:
- Table 27—For trees under 75 years in age.
- Table 28—For trees over 75 years in age.
- Table 29—Clear and used lengths of trees of different diameters and heights.

Table 30—Black ash form table for trees over 75 years in age.

VOLUME TABLES.

[Based on Form Tables 25–30.]

Tables 31 to 37—White ash volume tables:
- Table 31—Volume in cubic feet, peeled, for trees under 75 years in age.
- Table 32—Volume in cubic feet, peeled, for trees over 75 years in age.
- Table 33—Volume in cords, and per cent of bark, for trees under 75 years in age.
- Table 34—Volume in cords, and per cent of bark, for trees over 75 years in age.
- Table 35—Volume and per cent of branch wood.
- Table 36—Volume table in board feet for trees of varying diameters and numbers of logs under 75 years in age.
- Table 37—Volume table in board feet for trees of varying diameters and numbers of logs over 75 years in age.

Tables 38 to 43—Green ash volume tables:
- Table 38—Volume in cubic feet, peeled, for trees under 75 years in age.
- Table 39—Volume in cubic feet, peeled, for trees over 75 years in age.
- Table 40—Volume in cords, and per cent of bark, for trees under 75 years in age.
- Table 41—Volume in cords, and per cent of bark, for trees over 75 years in age.
- Table 42—Volume table in board feet for trees of varying diameters and numbers of logs under 75 years in age.
- Table 43—Volume table in board feet for trees of varying diameters and numbers of logs over 75 years in age.

Tables 44 to 46—Black ash volume tables:
- Table 44—Volume in cubic feet, peeled, for trees over 75 years in age.
- Table 45—Volume in cords, and per cent of bark, for trees over 75 years in age.
- Table 46—Volume table in board feet for trees of varying diameters and numbers of logs over 75 years in age.

YIELD TABLES.

Tables 47 to 49—Yield of planted groves of green ash in the Plains States:
- Table 47—Yield of green ash in South Dakota.
- Table 48—Yield of green ash in Nebraska.
- Table 49—Yield of green ash in the Plains region.

TABLE 24.—*Double width of bark at breastheight for trees of different diameters and species.*

Diameter breast-high.	Green ash.			White ash.			Black ash.	
	Trees under 75 years old.	Trees 75 to 149 years old.	Basis.	Trees under 75 years old.	Trees 75 to 149 years old.	Basis.	Trees 75 to 300 years old.	Basis.
Inches.	*Inches.*	*Inches.*	*Trees.*	*Inches.*	*Inches.*	*Trees.*	*Inches.*	*Trees.*
2	.....	.....	.....	0.3	.....	.....	.....	.....
3	.4	.....	.....	.3	.....	9	.....	.....
4	.5	.....	.....	.4	.....	16	.....	.....
5	.6	.....	5	.5	.....	13	.....	.....
6	.7	.8	10	.6	.8	19	.5	.....
7	.7	.9	18	.6	.8	19	.5	2
8	.8	.9	18	.7	.9	15	.6	4
9	.8	.9	11	.8	1.0	23	.7	6
10	.9	1.0	19	.9	1.1	20	.8	8
11	.9	1.0	24	.9	1.2	32	.8	5
12	1.0	1.0	30	1.0	1.3	29	.8	10
13	1.0	1.0	51	1.1	1.3	34	.9	16
14	1.0	1.1	67	1.2	1.4	21	1.0	4
15	1.0	1.1	45	1.2	1.5	28	1.1	9
16	1.0	1.1	52	1.3	1.6	25	1.2	12
17	1.1	1.1	48	1.4	1.7	21	1.2	4
18	1.1	1.1	47	1.5	1.8	9	1.3	7
19	1.1	1.1	40	1.6	1.9	14	1.3	5
20	1.1	1.1	42	1.6	1.9	9	1.3	3
21	1.1	1.2	41	1.7	2.0	4	1.3	8
22	1.1	1.2	42	1.8	2.1	6	1.3	2
23	1.1	1.2	32	1.9	2.2	4	1.4	2
24	1.1	1.2	30	2.0	2.3	1	1.5	1
25	1.1	1.2	23	.....	2.4	2	1.5	2
26	1.1	1.3	21	.....	2.5	.....	1.5	1
27	.....	1.3	18	.....	2.6	.....	1.6	2
28	.....	1.3	18	.....	2.6	1	1.6	1
29	.....	1.3	10	.....	2.7	.....	1.7	1
30	.....	1.4	11	.....	2.8	1	1.8	1
31	.....	1.4	5	.....	.....	.....	.....	.....
32	.....	1.4	5	.....	.....	.....	.....	.....
33	.....	1.5	2	.....	.....	.....	.....	.....
34	.....	1.5	3	.....	.....	.....	.....	.....
35	.....	1.5	2	.....	.....	.....	.....	.....
36	.....	1.5	1	.....	.....	.....	.....	.....
37	.....	1.6	1	.....	.....	.....	.....	.....
38	.....	1.6	2	.....	.....	.....	.....	.....
39	.....	1.6	.....	.....	.....	.....	.....	.....
40	.....	1.7	1	.....	.....	.....	.....	.....
			795			375		116

TABLE 25.—*Form or taper for WHITE ASH trees of different diameters and heights under 75 years of age, giving diameters inside bark at different heights above the ground.*

20-FOOT TREES.

Diameter breast-high.	Height above ground—feet.													Basis.
	1	2	3	4.5	9.15	17.3	25.45	33.6	41.75	49.9	58.05	66.2	74.35	
	Diameter inside bark—inches.													
Inches.														*Trees.*
2	2.4	2.2	2.0	1.7	1.1	.....	.....	.....	.....	.....	.....	.....	.....	53
3	3.5	3.2	3.0	2.7	1.7	.....	.....	.....	.....	.....	.....	.....	.....	5
4	4.6	4.3	4.0	3.6	2.2	.....	.....	.....	.....	.....	.....	.....	.....	.....
5	5.7	5.3	4.9	4.5	2.9	.....	.....	.....	.....	.....	.....	.....	.....	.....
6	6.9	6.3	5.9	5.4	3.5	.....	.....	.....	.....	.....	.....	.....	.....	.....
														58

TABLE 25.—*Form or taper for WHITE ASH trees of different diameters and heights under 75 years of age, giving diameters inside bark at different heights above the ground*—Continued.

30-FOOT TREES.

Diameter breast-high.	Height above ground—feet.													Basis.
	1	2	3	4.5	9.15	17.3	25.45	33.6	41.75	49.9	58.05	66.2	74.35	
	Diameter inside bark—inches.													
Inches.														*Trees.*
2	2.4	2.2	2.0	1.7	1.4	.9	.....	.....	.....	.....	.....	.....	.....	10
3	3.5	3.2	3.0	2.7	2.1	1.3	.....	.....	.....	.....	.....	.....	.....	20
4	4.6	4.3	4.0	3.6	2.8	1.8	.....	.....	.....	.....	.....	.....	.....	7
5	5.7	5.3	4.9	4.5	3.4	2.2	.....	.....	.....	.....	.....	.....	.....	4
6	6.9	6.3	5.9	5.4	4.2	2.7	.....	.....	.....	.....	.....	.....	.....	.....
7	8.0	7.4	6.9	6.4	4.8	3.1	.....	.....	.....	.....	.....	.....	.....	.....
8	9.2	8.5	7.9	7.3	5.6	3.6	.....	.....	.....	.....	.....	.....	.....	.....
														41

40-FOOT TREES.

2	2.4	2.2	2.0	1.7	1.5	1.2	.8	.....	.....	.....	.....	.....	.....	.....
3	3.5	3.2	3.0	2.7	2.3	1.8	1.3	.....	.....	.....	.....	.....	.....	22
4	4.6	4.3	4.0	3.6	3.1	2.5	1.7	.....	.....	.....	.....	.....	.....	33
5	5.7	5.3	4.9	4.5	3.9	3.0	2.1	.....	.....	.....	.....	.....	.....	26
6	6.9	6.3	5.9	5.4	4.7	3.7	2.6	.....	.....	.....	.....	.....	.....	12
7	8.0	7.4	6.9	6.4	5.5	4.3	3.0	.....	.....	.....	.....	.....	.....	2
8	9.2	8.5	7.9	7.3	6.3	4.9	3.4	.....	.....	.....	.....	.....	.....	4
9	10.4	9.5	8.9	8.2	7.1	5.5	3.9	.....	.....	.....	.....	.....	.....	1
10	11.7	10.6	9.9	9.1	7.9	6.1	4.3	.....	.....	.....	.....	.....	.....	.....
11	12.9	11.7	10.9	10.1	8.7	6.7	4.8	.....	.....	.....	.....	.....	.....	.....
12	14.1	12.8	11.9	11.0	9.4	7.3	5.2	.....	.....	.....	.....	.....	.....	.....
														100

50-FOOT TREES.

4	4.6	4.3	4.0	3.6	3.2	2.7	2.2	1.6	.....	.....	.....	.....	.....	25
5	5.7	5.3	4.9	4.5	4.1	3.4	2.8	2.0	.....	.....	.....	.....	.....	25
6	6.9	6.3	5.9	5.4	4.9	4.1	3.4	2.5	.....	.....	.....	.....	.....	27
7	8.0	7.4	6.9	6.4	5.7	4.8	3.9	2.8	.....	.....	.....	.....	.....	12
8	9.2	8.5	7.9	7.3	6.5	5.5	4.5	3.3	.....	.....	.....	.....	.....	14
9	10.4	9.5	8.9	8 2	7.4	6.2	5.0	3.6	.....	.....	.....	.....	.....	3
10	11.7	10.6	9.9	9.1	8.2	6.9	5.6	4.1	.....	.....	.....	.....	.....	2
11	12.9	11.7	10.9	10.1	9.0	7.5	6.1	4.5	.....	.....	.....	.....	.....	2
12	14.1	12.8	11.9	11.0	9.8	8.3	6.7	4.9	.....	.....	.....	.....	.....	2
13	15.3	14.0	13.0	11.9	10.7	9.0	7.3	5.4	.....	.....	.....	.....	.....	1
14	16.5	15.1	14.0	12.8	11.5	9.6	7.9	5.8	.....	.....	.....	.....	.....	1
15	17.6	16.2	15.0	13.8	12.3	10.3	8.4	6.2	.....	.....	.....	.....	.....	1
16	18.8	17.3	16.1	14.7	13.1	10.9	8.9	6.7	.....	.....	.....	.....	.....	.....
														115

60-FOOT TREES.

4	4.6	4.3	4.0	3.6	3.4	3.1	2.7	2.2	1.5	0.9	.....	.....	.....	.....
5	5.7	5.3	4.9	4.5	4.2	3.8	3.3	2.7	2.0	1.2	.....	.....	.....	13
6	6.9	6.3	5.9	5.4	5.1	4.5	3.9	3.2	2.4	1.4	.....	.....	.....	30
7	8.0	7.4	6.9	6.4	5.9	5.2	4.5	3.7	2.8	1.6	.....	.....	.....	29
8	9.2	8.5	7.9	7.3	6.7	5.9	5.1	4.3	3.2	1.9	.....	.....	.....	37
9	10.4	9.5	8.9	8.2	7.5	6.6	5.8	4.8	3.6	2.1	.....	.....	.....	19
10	11.7	10.6	9.9	9.1	8.3	7.3	6.4	5.3	3.9	2.3	.....	.....	.....	12
11	12.9	11.7	10.9	10.1	9.1	8.1	7.0	5.8	4.4	2.6	.....	.....	.....	10
12	14.1	12.8	11.9	11.0	10.0	8.8	7.6	6.4	4.8	2.9	.....	.....	.....	6
13	15.3	14.0	13.0	11.9	10.8	9.5	8.3	6.9	5.2	3.1	.....	.....	.....	2
14	16.5	15.1	14.0	12.8	11.6	10.3	8.9	7.5	5.6	3.4	.....	.....	.....	1
15	17.6	16.2	15.0	13.8	12.5	11.0	9.6	8.1	6.0	3.6	.....	.....	.....	1
16	18.8	17.3	16.1	14.7	13.3	11.7	10.3	8.6	6.5	3.9	.....	.....	.....	2
17	20.0	18.4	17.1	15.6	14.2	12.5	11.0	9.1	6.8	4.2	.....	.....	.....	3
18	21.2	19.5	18.2	16.5	15.0	13.3	11.7	9.7	7.3	4.4	.....	.....	.....	1
19	22.3	20.6	19.2	17.4	15.9	14.1	12.3	10.2	7.6	4.7	.....	.....	.....	1
20	23.5	21.7	20.2	18.4	16.7	14.9	13.0	10.8	8.1	4.9	.....	.....	.....	.....
21	24.6	22.8	21.3	19.3	17.5	15.6	13.7	11.3	8.5	5.2	.....	.....	.....	.....
22	25.8	23.9	22.3	20.2	18.4	16.4	14.4	11.8	8.9	5.5	.....	.....	.....	1
														168

TABLE 25.—*Form or taper for WHITE ASH trees of different diameters and heights under 75 years of age, giving diameters inside bark at different heights above the ground*—Continued.

70-FOOT TREES.

Diameter breast-high.	Height above ground—feet.													Basis.
	1	2	3	4.5	9.15	17.3	25.45	33.6	41.75	49.9	58.05	66.2	74.35	
	Diameter inside bark—inches.													
Inches.														*Trees.*
4	4.6	4.3	4.0	3.6	3.5	3.2	2.9	2.5	2.0	1.5	.....	.....	.....	.....
5	5.7	5.3	4.9	4.5	4.3	3.9	3.5	3.1	2.5	1.9	.....	.....	.....	2
6	6.9	6.3	5.9	5.4	5.1	4.7	4.2	3.7	3.1	2.3	.....	.....	.....	11
7	8.0	7.4	6.9	6.4	5.9	5.4	4.9	4.3	3.5	2.7	.....	.....	.....	14
8	9.2	8.5	7.9	7.3	6.7	6.2	5.6	4.9	4.1	3.0	.....	.....	.....	22
9	10.4	9.5	8.9	8.2	7.5	6.8	6.3	5.5	4.6	3.4	.....	.....	.....	26
10	11.7	10.6	9.9	9.1	8.4	7.7	7.0	6.1	5.1	3.8	.....	.....	.....	32
11	12.9	11.7	10.9	10.1	9.2	8.4	7.6	6.7	5.5	4.2	.....	.....	.....	27
12	14.1	12.8	11.9	11.0	10.0	9.2	8.3	7.3	6.1	4.6	.....	.....	.....	18
13	15.3	14.0	13.0	11.9	10.9	9.9	9.0	7.9	6.6	5.0	.....	.....	.....	12
14	16.5	15.1	14.0	12.8	11.7	10.7	9.7	8.5	7.1	5.4	.....	.....	.....	7
15	17.6	16.2	15.0	13.8	12.6	11.3	10.3	9.1	7.7	5.8	.....	.....	.....	6
16	18.8	17.3	16.1	14.7	13.4	12.2	11.0	9.7	8.1	6.3	.....	.....	.....	5
17	20.0	18.4	17.1	15.6	14.2	12.9	11.7	10.3	8.7	6.6	.....	.....	.....	3
18	21.2	19.5	18.2	16.5	15.0	13.6	12.3	10.9	9.1	7.0	.....	.....	.....	1
19	22.3	20.6	19.2	17.4	15.9	14.3	13.0	11.5	9.6	7.3	.....	.....	.....	1
20	23.5	21.7	20.2	18.4	16.7	15.1	13.7	12.2	10.2	7.8	.....	.....	.....	1
21	24.6	22.8	21.3	19.3	17.6	15.7	14.4	12.7	10.6	8.2	.....	.....	.....	1
22	25.8	23.9	22.3	20.2	18.4	16.5	15.1	13.3	11.1	8.5	.....	.....	.....	.....
														189

80-FOOT TREES.

6	6.9	6.3	5.9	5.4	5.2	4.8	4.4	4.0	3.4	2.8	2.0	.....	1
7	8.0	7.4	6.9	6.4	6.0	5.6	5.2	4.6	4.0	3.3	2.4	.....	.....
8	9.2	8.5	7.9	7.3	6.8	6.4	5.9	5.3	4.5	3.7	2.7	.....	3
9	10.4	9.5	8.9	8.2	7.6	7.1	6.6	5.9	5.1	4.2	3.1	.....	8
10	11.7	10.6	9.9	9.1	8.5	7.9	7.3	6.5	5.7	4.7	3.5	.....	16
11	12.9	11.7	10.9	10.1	9.3	8.6	8.0	7.2	6.3	5.3	3.9	.....	14
12	14.1	12.8	11.9	11.0	10.1	9.4	8.7	7.8	6.9	5.8	4.3	.....	16
13	15.3	14.0	13.0	11.9	11.0	10.2	9.4	8.5	7.5	6.3	4.7	.....	12
14	16.5	15.1	14.0	12.8	11.8	10.9	10.1	9.2	8.0	6.8	5.1	.....	12
15	17.6	16.2	15.0	13.8	12.6	11.6	10.8	9.8	8.7	7.3	5.5	.....	6
16	18.8	17.3	16.1	14.7	13.5	12.4	11.4	10.5	9.3	7.8	5.9	.....	5
17	20.0	18.4	17.1	15.6	14.3	13.1	12.2	11.1	9.9	8.3	6.3	.....	3
18	21.2	19.5	18.2	16.5	15.1	13.9	12.9	11.8	10.4	8.8	6.7	.....	3
19	22.3	20.6	19.2	17.4	16.0	14.5	13.6	12.5	11.1	9.3	7.1	.....	3
20	23.5	21.7	20.2	18.4	16.9	15.3	14.3	13.2	11.7	9.8	7.5	.....	2
21	24.6	22.8	21.3	19.3	17.7	16.0	14.9	13.8	12.4	10.3	7.9	.....	3
22	25.8	23.9	22.3	20.2	18.5	16.7	15.5	14.5	12.9	10.8	8.2	.....	.....
													107

90-FOOT TREES.

8	9.2	8.5	7.9	7.3	6.8	6.4	6.0	5.5	4.9	4.2	3.3	2.3	1.4	.....
9	10.4	9.5	8.9	8.2	7.6	7.2	6.8	6.2	5.5	4.8	3.8	2.7	1.7	.....
10	11.7	10.6	9.9	9.1	8.5	8.0	7.5	6.9	6.2	5.4	4.3	3.1	1.9	1
11	12.9	11.7	10.9	10.1	9.3	8.7	8.2	7.5	6.8	6.0	4.9	3.5	2.2	1
12	14.1	12.8	11.9	11.0	10.2	9.6	9.1	8.3	7.6	6.6	5.4	3.9	2.5	3
13	15.3	14.0	13.0	11.9	11.0	10.3	9.8	9.0	8.2	7.3	5.9	4.3	2.8	6
14	16.5	15.1	14.0	12.8	12.0	11.2	10.5	9.8	9.0	7.9	6.5	4.9	3.2	7
15	17.6	16.2	15.0	13.8	12.7	11.9	11.2	10.4	9.6	8.5	7.0	5.3	3.5	4
16	18.8	17.3	16.1	14.7	13.6	12.7	11.9	11.1	10.3	9.2	7.6	5.7	3.9	2
17	20.0	18.4	17.1	15.6	14.5	13.4	12.6	11.8	11.0	9.8	8.1	6.2	4.2	.....
18	21.2	19.7	18.2	16.5	15.3	14.2	13.3	12.5	11.7	10.4	8.6	6.7	4.6	1
19	22.3	20.6	19.2	17.4	16.1	14.8	14.0	13.2	12.3	11.0	9.2	7.2	4.9	1
20	23.5	21.7	20.2	18.4	17.0	15.7	14.7	13.9	13.0	11.5	9.7	7.6	5.3	.....
21	24.6	22.8	21.3	19.3	17.7	16.3	15.3	14.5	13.7	12.2	10.4	8.2	5.8	.....
22	25.8	23.9	22.3	20.2	18.6	17.1	16.1	15.3	14.5	12.9	10.9	8.6	6.1	.....
														26

TABLE 26.—*Form or taper for WHITE ASH trees of different diameters and heights, 75 to 149 years in age, giving diameters inside bark at different heights above the ground.*

50-FOOT TREES.

Diameter, breast-high.	Height above ground—feet.																	Basis.
	1	2	3	4.5	9.15	17.3	25.45	33.6	41.75	49.9	58.05	66.2	74.35	82.5	90.65	98.8	106.95	
	Diameter inside bark—inches.																	
Inches.																		*Trees.*
6	6.7	6.2	5.6	5.2	4.5	4.0	3.4	2.4	1.1	.....	.....	.....	.....	.....	.....	.....	.....	3
7	7.7	7.2	6.6	6.2	5.5	4.8	4.1	3.1	1.7	.....	.....	.....	.....	.....	.....	.....	.....	3
8	8.7	8.2	7.6	7.1	6.4	5.7	4.9	3.7	2.0	.....	.....	.....	.....	.....	.....	.....	.....	6
9	9.8	9.2	8.6	8.0	7.3	6.4	5.5	4.3	2.5	.....	.....	.....	.....	.....	.....	.....	.....	4
10	10.8	10.2	9.5	8.9	8.2	7.3	6.3	4.9	2.9	.....	.....	.....	.....	.....	.....	.....	.....	2
11	11.9	11.1	10.4	9.8	9.1	8.1	7.1	5.7	3.3	.....	.....	.....	.....	.....	.....	.....	.....	5
12	12.9	12.1	11.3	10.7	9.9	8.9	7.8	6.2	3.7	.....	.....	.....	.....	.....	.....	.....	.....	4
13	14.0	13.1	12.3	11.7	10.9	9.7	8.5	6.9	4.1	.....	.....	.....	.....	.....	.....	.....	.....	5
14	15.1	14.1	13.3	12.6	11.7	10.5	9.2	7.5	4.5	.....	.....	.....	.....	.....	.....	.....	.....	4
15	16.2	15.1	14.2	13.5	12.6	11.3	10.0	8.1	5.1	.....	.....	.....	.....	.....	.....	.....	.....	2
16	17.2	16.1	15.2	14.4	13.4	12.1	10.7	8.7	5.4	.....	.....	.....	.....	.....	.....	.....	.....	3
17	18.3	17.1	16.2	15.3	14.4	12.9	11.4	9.5	5.8	.....	.....	.....	.....	.....	.....	.....	.....	3
18	19.4	18.1	17.1	16.2	15.2	13.7	12.1	10.0	6.4	.....	.....	.....	.....	.....	.....	.....	.....	2
19	20.4	19.1	18.1	17.1	16.1	14.4	12.8	10.6	6.7	.....	.....	.....	.....	.....	.....	.....	.....	.....
20	21.5	20.1	19.0	18.1	16.9	15.2	13.5	11.2	7.2	.....	.....	.....	.....	.....	.....	.....	.....	1
21	22.6	21.1	20.0	19.0	17.8	16.0	14.2	11.8	7.7	.....	.....	.....	.....	.....	.....	.....	.....	.....
22	23.7	22.1	21.0	19.9	18.7	16.8	14.9	12.5	8.2	.....	.....	.....	.....	.....	.....	.....	.....	.....
																		47

60-FOOT TREES.

6	6.7	6.2	5.6	5.2	4.7	4.4	3.8	3.0	2.1	1.1	.....	.....	.....	.....	.....	.....	.....	2
7	7.7	7.2	6.6	6.2	5.7	5.1	4.5	3.7	2.7	1.4	.....	.....	.....	.....	.....	.....	.....	4
8	8.7	8.2	7.6	7.1	6.5	5.9	5.2	4.3	3.1	1.7	.....	.....	.....	.....	.....	.....	.....	3
9	9.8	9.2	8.6	8.0	7.4	6.7	6.0	5.0	3.7	2.1	.....	.....	.....	.....	.....	.....	.....	10
10	10.8	10.2	9.5	8.9	8.2	7.5	6.6	5.6	4.2	2.3	.....	.....	.....	.....	.....	.....	.....	7
11	11.9	11.1	10.4	9.8	9.1	8.3	7.5	6.3	4.7	2.7	.....	.....	.....	.....	.....	.....	.....	9
12	12.9	12.1	11.3	10.7	10.0	9.1	8.1	6.9	5.2	3.0	.....	.....	.....	.....	.....	.....	.....	10
13	14.0	13.1	12.3	11.7	10.9	9.9	8.9	7.6	5.6	3.4	.....	.....	.....	.....	.....	.....	.....	2
14	15.1	14.1	13.3	12.6	11.7	10.7	9.5	8.2	6.2	3.7	.....	.....	.....	.....	.....	.....	.....	6
15	16.2	15.1	14.2	13.5	12.6	11.4	10.2	8.8	6.7	4.0	.....	.....	.....	.....	.....	.....	.....	4

16	17.2	16.1	15.2	14.4	13.5	12.3	11.0	9.5	7.3	4.4								5
17	18.3	17.1	16.2	15.3	14.4	13.0	11.7	10.2	7.8	4.7								1
18	19.4	18.1	17.1	16.2	15.2	13.7	12.4	10.7	8.3	5.0								1
19	20.4	19.1	18.1	17.1	16.1	14.5	13.1	11.4	8.9	5.3								2
20	21.5	20.1	19.0	18.1	16.9	15.3	13.7	12.0	9.4	5.7								2
21	22.6	21.1	20.0	19.0	17.9	16.1	14.4	12.6	9.9	6.0								
22	23.7	22.1	21.0	19.9	18.7	16.9	15.1	13.2	10.4	6.3								
23	24.8	23.2	21.9	20.8	19.5	17.6	15.8	13.9	10.9	6.7								
24	25.9	24.2	22.9	21.7	20.3	18.3	16.5	14.4	11.4	7.0								
25	27.0	25.2	23.9	22.6	21.2	19.1	17.2	15.1	11.9	7.4								
26	28.2	26.2	24.8	23.5	22.0	19.8	17.8	15.7	12.5	7.7								
																		68

70-FOOT TREES.

6	6.7	6.2	5.6	5.2	4.9	4.6	4.1	3.5	2.8	2.0	1.2							
7	7.7	7.2	6.6	6.2	5.8	5.3	4.8	4.1	3.5	2.6	1.5							1
8	8.7	8.2	7.6	7.1	6.7	6.1	5.6	4.9	4.1	3.1	1.8							4
9	9.8	9.2	8.6	8.0	7.5	6.9	6.3	5.6	4.7	3.6	2.2							4
10	10.8	10.2	9.5	8.9	8.3	7.7	7.0	6.2	5.3	4.0	2.5							10
11	11.9	11.1	10.4	9.8	9.2	8.4	7.7	6.9	5.9	4.6	2.8							10
12	12.9	12.1	11.3	10.7	10.0	9.2	8.5	7.6	6.4	5.0	3.1							11
13	14.0	13.1	12.3	11.7	10.9	10.0	9.2	8.3	7.0	5.4	3.4							15
14	15.1	14.1	13.3	12.6	11.7	10.7	9.9	8.9	7.6	5.9	3.6							19
15	16.2	15.1	14.2	13.5	12.7	11.5	10.6	9.5	8.2	6.3	3.9							12
16	17.2	16.1	15.2	14.4	13.5	12.3	11.3	10.2	8.7	6.7	4.1							17
17	18.3	17.1	16.2	15.3	14.4	13.1	12.0	10.8	9.2	7.2	4.5							8
18	19.4	18.1	17.1	16.2	15.2	13.9	12.7	11.4	9.7	7.6	4.7							7
19	20.4	19.1	18.1	17.1	16.2	14.6	13.5	12.1	10.2	8.0	5.0							4
20	21.5	20.1	19.0	18.1	17.0	15.4	14.1	12.7	10.7	8.4	5.2							3
21	22.6	21.1	20.0	19.0	17.9	16.2	14.8	13.2	11.2	8.7	5.4							1
22	23.7	22.1	21.0	19.9	18.7	16.9	15.4	13.9	11.7	9.1	5.6							2
23	24.8	23.2	21.9	20.8	19.6	17.7	16.1	14.4	12.2	9.5	5.9							3
24	25.9	24.2	22.9	21.7	20.4	18.5	16.7	15.0	12.7	9.9	6.1							
25	27.0	25.2	23.9	22.6	21.2	19.2	17.4	15.5	13.1	10.2	6.4							
26	28.2	26.2	24.8	23.5	22.1	20.0	18.0	16.0	13.6	10.6	6.6							1
97	29.3	27.2	25.8	24.4	23.0	20.8	18.7	16.6	14.1	10.9	6.8							
28	30.5	28.2	26.8	25.4	23.7	21.4	19.2	17.0	14.6	11.3	7.0							1
22	31.7	29.3	27.8	26.3	24.6	22.3	19.9	17.6	15.1	11.7	7.3							
30	32.8	30.3	28.8	27.2	25.4	22.9	20.5	18.1	15.5	12.0	7.5							
																		133

TABLE 26.—*Form or taper for WHITE ASH trees of different diameters and heights, 75 to 149 years in age, giving diameters inside bark at different heights above the ground*—Continued.

80-FOOT TREES.

Diameter, breast-high.	Height above ground—feet.																	Basis.
	1	2	3	4.5	9.15	17.3	25.45	33.6	41.75	49.9	58.05	66.2	74.35	82.5	90.65	98.8	106.95	
	Diameter inside bark—inches.																	
Inches.																		*Trees.*
8	8.7	8.2	7.6	7.1	6.7	6.2	5.9	5.4	4.9	4.1	3.1	1.9						
9	9.8	9.2	8.6	8.0	7.6	7.0	6.6	6.1	5.4	4.7	3.5	2.2						5
10	10.8	10.2	9.5	8.9	8.5	7.8	7.3	6.7	6.0	5.1	3.9	2.5						3
11	11.9	11.1	10.4	9.8	9.2	8.6	8.0	7.3	6.6	5.7	4.4	2.7						13
12	12.9	12.1	11.3	10.7	10.2	9.4	8.7	8.0	7.2	6.2	4.7	3.0						15
13	14.0	13.1	12.3	11.7	11.0	10.1	9.4	8.6	7.8	6.8	5.1	3.3						13
14	15.1	14.1	13.3	12.6	11.9	10.9	10.1	9.3	8.3	7.2	5.5	3.5						8
15	16.2	15.1	14.2	13.5	12.8	11.7	10.8	10.0	8.9	7.7	5.9	3.7						6
16	17.2	16.1	15.2	14.4	13.6	12.5	11.5	10.6	9.5	8.1	6.3	4.1						9
17	18.3	17.1	16.2	15.3	14.5	13.3	12.2	11.3	10.0	8.6	6.6	4.3						4
18	19.4	18.1	17.1	16.2	15.3	14.0	13.0	11.9	10.6	9.1	7.0	4.6						7
19	20.4	19.1	18.1	17.1	16.1	14.8	13.7	12.6	11.1	9.5	7.3	4.8						6
20	21.5	20.1	19.0	18.1	17.1	15.6	14.4	13.3	11.8	10.0	7.8	5.1						6
21	22.6	21.1	20.0	19.0	17.9	16.4	15.1	13.8	12.2	10.4	8.1	5.3						3
22	23.7	22.1	21.0	19.9	18.8	17.2	15.8	14.5	12.9	10.9	8.5	5.6						2
23	24.8	23.2	21.9	20.8	19.6	17.9	16.5	15.1	13.4	11.4	8.9	5.9						
24	25.9	24.2	22.9	21.7	20.5	18.7	17.2	15.7	14.0	11.9	9.2	6.1						
25	27.0	25.2	23.9	22.6	21.3	19.5	17.9	16.3	14.4	12.2	9.5	6.3						2
26	28.2	26.2	24.8	23.5	22.2	20.3	18.6	16.9	15.0	12.7	9.8	6.5						
27	29.3	27.2	25.8	24.4	23.1	21.1	19.4	17.5	15.5	13.2	10.2	6.7						
28	30.5	28.2	26.8	25.4	24.0	21.9	20.0	18.1	16.0	13.5	10.5	7.0						
29	31.7	29.3	27.8	26.3	24.8	22.6	20.7	18.6	16.5	14.0	10.9	7.2						
30	32.8	30.3	28.8	27.2	25.8	23.5	21.3	19.2	17.0	14.4	11.2	7.5						
31	34.0	31.3	29.7	28.2	26.7	24.3	22.0	19.8	17.5	14.8	11.5	7.7						
32	35.1	32.4	30.7	29.1	27.6	25.1	22.6	20.3	17.9	15.1	11.8	8.0						
33	36.3	33.4	31.7	30.0	28.5	26.0	23.3	20.8	18.3	15.5	12.3	8.2						
34	37.4	34.4	32.7	31.0	29.4	26.6	24.0	21.5	18.9	16.0	12.5	8.5						
35	38.6	35.5	33.7	31.9	30.3	27.6	24.7	22.0	19.3	16.3	12.8	8.7						
36	39.8	36.5	34.6	32.8	31.1	28.2	25.3	22.6	19.8	16.7	13.1	8.9						
																		102

90-FOOT TREES.

10	10.8	10.2	9.5	8.9	8.6	8.0	7.6	7.1	6.6	5.9	5.1	3.7	2.2					6
11	11.9	11.1	10.4	9.8	9.4	8.8	8.2	7.7	7.2	6.5	5.6	4.1	2.6					5
12	12.9	12.1	11.3	10.7	10.3	9.6	9.0	8.5	7.9	7.1	6.0	4.5	2.9					9
13	14.0	13.1	12.3	11.7	11.2	10.4	9.7	9.1	8.5	7.6	6.5	5.0	3.3					11
14	15.1	14.1	13.3	12.6	12.1	11.1	10.4	9.8	9.1	8.2	7.0	5.4	3.6					13
15	16.2	15.1	14.2	13.5	12.9	11.9	11.1	10.4	9.7	8.7	7.4	5.8	4.0					5
16	17.2	16.1	15.2	14.4	13.7	12.7	11.9	11.1	10.4	9.3	7.9	6.1	4.2					16
17	18.3	17.1	16.2	15.3	14.6	13.5	12.5	11.8	11.0	9.9	8.4	6.6	4.6					10
18	19.4	18.1	17.1	16.2	15.4	14.2	13.2	12.4	11.6	10.4	8.8	6.9	4.9					4
19	20.4	19.1	18.1	17.1	16.3	15.0	14.0	13.1	12.2	10.9	9.2	7.3	5.2					1
20	21.5	20.1	19.0	18.1	17.2	15.9	14.7	13.8	12.8	11.4	9.7	7.7	5.5					1
21	22.6	21.1	20.0	19.0	18.0	16.6	15.4	14.4	13.3	12.0	10.2	8.1	5.8					2
22	23.7	22.1	21.0	19.9	19.0	17.4	16.2	15.2	14.0	12.5	10.6	8.5	6.0					
23	24.8	23.2	21.9	20.8	19.7	18.2	17.0	15.8	14.6	13.1	11.0	8.8	6.4					2
24	25.9	24.2	22.9	21.7	20.6	19.0	17.7	16.5	15.2	13.5	11.5	9.3	6.7					1
25	27.0	25.2	23.9	22.6	21.4	19.8	18.5	17.3	15.8	14.1	12.0	9.6	7.0					1
26	28.2	26.2	24.8	23.5	22.4	20.6	19.2	17.9	16.4	14.6	12.4	9.9	7.2					
27	29.3	27.2	25.8	24.4	23.2	21.4	20.0	18.6	16.9	15.0	12.8	10.3	7.5					
28	30.5	28.2	26.8	25.4	24.1	22.2	20.7	19.2	17.5	15.5	13.3	10.7	7.7					
29	31.7	29.3	27.8	26.3	25.0	23.0	21.4	19.9	18.2	16.1	13.7	11.0	8.0					1
30	32.8	30.3	28.8	27.2	25.9	23.8	22.2	20.6	18.7	16.6	14.1	11.4	8.3					
31	34.0	31.3	29.7	28.2	26.8	24.7	22.9	21.2	19.3	17.1	14.5	11.7	8.6					1
32	35.1	32.4	30.7	29.1	27.7	25.5	23.6	21.9	19.9	17.6	15.0	12.1	8.8					
33	36.3	33.4	31.7	30.0	28.5	26.3	24.4	22.5	20.4	18.1	15.4	12.5	9.0					
34	37.4	34.4	32.7	31.0	29.6	27.2	25.1	23.2	21.1	18.6	15.8	12.8	9.2					
35	38.6	35.5	33.7	31.9	30.4	27.9	25.8	23.8	21.6	19.1	16.3	13.1	9.5					
36	39.8	36.5	34.6	32.8	31.3	28.8	26.5	24.4	22.1	19.6	16.8	13.6	9.8					
																		89

TABLE 26.—*Form or taper for WHITE ASH trees of different diameters and heights, 75 to 149 years in age, giving diameters inside bark at different heights above the ground*—Continued.

100-FOOT TREES.

Diameter, breast-high.	Height above ground—feet.																Basis.
	1	2	3	4.5	9.15	17.3	25.45	33.6	41.75	49.9	58.05	66.2	74.35	82.5	90.65	98.8	106.95	
	Diameter inside bark—inches.																	
Inches.																		*Trees.*
12	12.9	12.1	11.3	10.7	10.2	9.7	9.1	8.7	8.2	7.5	6.7	5.7	4.4	2.9	1.5	.....	.....	.....
13	14.0	13.1	12.3	11.7	11.2	10.5	9.9	9.4	8.9	8.1	7.3	6.2	4.8	3.2	1.7	.....	.....	.....
14	15.1	14.1	13.3	12.6	12.0	11.3	10.6	10.0	9.5	8.8	7.8	6.6	5.2	3.6	1.9	.....	.....	1
15	16.2	15.1	14.2	13.5	12.9	12.0	11.4	10.8	10.1	9.4	8.4	7.1	5.7	4.0	2.1	.....	.....	3
16	17.2	16.1	15.2	14.4	13.8	12.8	12.1	11.5	10.8	9.9	8.8	7.6	6.1	4.3	2.3	.....	.....	1
17	18.3	17.1	16.2	15.3	14.6	13.6	12.8	12.2	11.4	10.5	9.4	8.1	6.5	4.6	2.5	.....	.....	4
18	19.4	18.1	17.1	16.2	15.5	14.4	13.6	12.9	12.1	11.1	9.9	8.6	6.9	4.9	2.7	.....	.....	2
19	20.4	19.1	18.1	17.1	16.4	15.2	14.3	13.6	12.7	11.7	10.5	9.1	7.4	5.3	2.9	.....	.....	4
20	21.5	20.1	19.0	18.1	17.3	16.0	15.1	14.3	13.4	12.3	11.1	9.5	7.7	5.6	3.1	.....	.....	2
21	22.6	21.1	20.0	19.0	18.1	16.8	15.8	15.0	14.0	12.9	11.6	10.1	8.2	6.0	3.4	.....	.....	3
22	23.7	22.1	21.0	19.9	18.9	17.5	16.5	15.7	14.7	13.5	12.2	10.6	8.6	6.2	3.6	.....	.....	4
23	24.8	23.2	21.9	20.8	19.8	18.3	17.3	16.4	15.4	14.1	12.7	11.1	9.1	6.6	3.8	.....	.....	2
24	25.9	24.2	22.9	21.7	20.7	19.2	18.1	17.1	16.1	14.8	13.3	11.5	9.4	6.8	4.0	.....	.....	.....
25	27.0	25.2	23.9	22.6	21.6	20.0	18.8	17.8	16.6	15.3	13.8	12.0	9.8	7.2	4.1	.....	.....	1
26	28.2	26.2	24.8	23.5	22.4	20.8	19.6	18.5	17.3	16.0	14.4	12.5	10.3	7.5	4.3	.....	.....	.....
27	29.3	27.2	25.8	24.4	23.3	21.6	20.3	19.3	18.0	16.6	14.9	13.0	10.7	7.8	4.5	.....	.....	.....
28	30.5	28.2	26.8	25.4	24.3	22.5	21.1	20.0	18.7	17.2	15.5	13.7	11.1	8.1	4.7	.....	.....	.....
29	31.7	29.3	27.8	26.3	25.2	23.3	21.9	20.7	19.4	17.8	16.0	14.0	11.5	8.4	4.8	.....	.....	.....
30	32.8	30.3	28.8	27.2	26.0	24.1	22.7	21.4	20.1	18.5	16.6	14.5	11.9	8.7	5.0	.....	.....	.....
31	34.0	31.3	29.7	28.2	26.9	25.0	23.5	22.2	20.7	19.1	17.1	15.0	12.3	9.0	5.2	.....	.....	.....
32	35.1	32.4	30.7	29.1	27.8	25.8	24.2	22.9	21.4	19.7	17.7	15.4	12.7	9.3	5.4	.....	.....	.....
33	36.3	33.4	31.7	30.0	28.7	26.7	25.0	23.6	22.1	20.3	18.2	16.0	13.2	9.6	5.6	.....	.....	.....
34	37.4	34.4	32.7	31.0	29.7	27.6	25.8	24.3	22.8	20.9	18.8	16.5	13.5	9.9	5.8	.....	.....	.....
35	38.6	35.5	33.7	31.9	30.5	28.3	26.5	25.0	23.4	21.5	19.3	16.9	13.9	10.2	5.9	.....	.....	.....
36	39.8	36.5	34.6	32.8	31.4	29.2	27.3	25.7	24.1	22.2	19.9	17.4	14.3	10.5	6.0	.....	.....	.....
																		27

110-FOOT TREES.

14	15.1	14.1	13.3	12.6	12.1	11.4	10.8	10.3	9.8	9.2	8.4	7.4	6.3	5.0	3.6	2.1	.....	.....
15	16.2	15.1	14.2	13.5	12.9	12.2	11.6	11.1	10.5	9.8	9.0	8.0	6.8	5.4	4.0	2.3	.....	.....

16	17.2	16.1	15.2	14.4	13.9	13.0	12.3	11.7	11.2	10.5	9.6	8.5	7.3	5.9	4.2	2.5	
17	18.3	17.1	16.2	15.3	14.7	13.8	13.1	12.5	11.9	11.1	10.3	9.1	7.8	6.3	4.6	2.6	
18	19.4	18.1	17.1	16.2	15.5	14.5	13.8	13.2	12.6	11.7	10.8	9.7	8.3	6.7	4.8	2.8	1
19	20.4	19.1	18.1	17.1	16.4	15.4	14.6	13.9	13.3	12.4	11.5	10.3	8.9	7.1	5.2	3.0	3
20	21.5	20.1	19.0	18.1	17.4	16.1	15.2	14.7	14.0	13.1	12.1	10.9	9.4	7.6	5.5	3.2	2
21	22.6	21.1	20.0	19.0	18.2	16.9	16.1	15.5	14.7	13.8	12.8	11.5	9.9	8.0	5.8	3.4	1
22	23.7	22.1	21.0	19.9	19.1	17.8	16.9	16.3	15.5	14.5	13.5	12.2	10.5	8.4	6.2	3.6	3
23	24.8	23.2	21.9	20.8	19.9	18.5	17.7	17.0	16.2	15.2	14.1	12.8	11.0	8.9	6.5	3.8	
24	25.9	24.2	22.9	21.7	20.8	19.4	18.5	17.7	16.9	15.9	14.8	13.4	11.5	9.3	6.9	4.0	
25	27.0	25.2	23.9	22.6	21.7	20.3	19.3	18.5	17.6	16.6	15.5	14.1	12.1	9.8	7.2	4.2	
26	28.2	26.2	24.8	23.5	22.6	21.1	20.2	19.4	18.4	17.3	16.1	14.6	12.6	10.2	7.5	4.5	1
27	29.3	27.2	25.8	24.4	23.4	22.0	21.0	20.2	19.2	18.1	16.8	15.2	13.2	10.7	7.9	4.7	1
28	30.5	28.2	26.8	25.4	24.4	22.8	21.7	20.8	19.8	18.7	17.5	15.8	13.7	11.0	8.3	4.9	
29	31.7	29.3	27.8	26.3	25.3	23.7	22.6	21.7	20.6	19.5	18.1	16.5	14.3	11.6	8.6	5.1	1
30	32.8	30.3	28.8	27.2	26.2	24.5	23.4	22.4	21.3	20.2	18.9	17.1	14.8	12.0	8.9	5.3	1
31	34.0	31.3	29.7	28.2	27.1	25.4	24.3	23.2	22.1	21.0	19.5	17.7	15.3	12.5	9.2	5.4	1
32	35.1	32.4	30.7	29.1	28.0	26.3	25.1	24.0	22.9	21.7	20.3	18.3	15.8	12.9	9.6	5.7	
33	36.3	33.4	31.7	30.0	28.9	27.2	25.9	24.7	23.6	22.4	20.8	18.9	16.4	13.4	9.9	5.9	
34	37.4	34.4	32.7	31.0	29.7	28.1	26.7	25.5	24.3	23.1	21.6	19.5	17.0	13.8	10.3	6.1	
35	38.6	35.5	33.7	31.9	30.6	29.0	27.6	26.3	25.1	23.9	22.3	20.2	17.6	14.3	10.7	6.3	1
36	39.8	36.5	34.6	32.8	31.5	29.9	28.5	27.1	25.8	24.6	22.9	20.7	18.0	14.8	11.0	6.5	
																	16

120-FOOT TREES.

16	17.2	16.1	15.2	14.4	13.9	13.1	12.5	12.0	11.5	10.8	10.1	9.3	8.3	7.1	5.7	4.2	2.5	
17	18.3	17.1	16.2	15.3	14.7	13.9	13.2	12.7	12.2	11.6	10.9	9.9	8.8	7.6	6.1	4.5	2.7	
18	19.4	18.1	17.1	16.2	15.7	14.7	14.0	13.4	12.9	12.3	11.5	10.6	9.4	8.0	6.5	4.7	2.8	
19	20.4	19.1	18.1	17.1	16.6	15.5	14.8	14.2	13.7	13.1	12.4	11.3	10.0	8.5	6.8	5.0	3.1	1
20	21.5	20.1	19.0	18.1	17.5	16.4	15.6	15.0	14.5	13.9	13.1	12.0	10.6	9.0	7.2	5.3	3.2	
21	22.6	21.1	20.0	19.0	18.2	17.1	16.4	15.8	15.3	14.6	13.8	12.7	11.3	9.5	7.6	5.5	3.4	
22	23.7	22.1	21.0	19.9	19.1	18.0	17.2	16.6	16.1	15.4	14.6	13.4	11.9	10.1	8.0	5.9	3.6	
23	24.8	23.2	21.9	20.8	20.0	18.8	18.0	17.5	16.9	16.1	15.4	14.2	12.5	10.6	8.4	6.2	3.8	
24	25.9	24.2	22.9	21.7	20.9	19.7	18.8	18.3	17.7	17.0	16.2	14.9	13.1	11.1	8.9	6.5	4.0	
25	27.0	25.2	23.9	22.6	21.7	20.5	19.6	19.1	18.5	17.7	17.0	15.6	13.9	11.8	9.4	6.8	4.2	1
26	28.2	26.2	24.8	23.5	22.7	21.4	20.4	19.9	19.3	18.5	17.7	16.3	14.5	12.3	9.8	7.2	4.4	
27	29.3	27.2	25.8	24.4	23.5	22.1	21.3	20.7	20.1	19.3	18.5	17.1	15.2	12.9	10.3	7.6	4.6	1
28	30.5	28.2	26.8	25.4	24.5	23.1	22.1	21.5	20.9	20.1	19.2	17.8	15.8	13.5	10.8	7.9	4.8	1
29	31.7	29.3	27.8	26.3	25.4	24.0	23.0	22.4	21.7	20.9	20.0	18.5	16.5	14.1	11.4	8.3	5.1	1
30	32.8	30.3	28.8	27.2	26.3	24.8	23.9	23.2	22.5	21.6	20.7	19.3	17.2	14.7	11.9	8.7	5.3	
31	34.0	31.3	29.7	28.2	27.2	25.8	24.9	24.2	23.4	22.5	21.5	20.1	17.9	15.3	12.4	9.1	5.6	
32	35.1	32.4	30.7	29.1	28.1	26.7	25.7	24.9	24.2	23.3	22.3	20.8	18.6	16.0	13.0	9.5	5.9	1
33	36.3	33.4	31.7	30.0	29.0	27.6	26.6	25.8	25.0	24.2	23.1	21.5	19.3	16.6	13.5	9.9	6.1	
34	37.4	34.4	32.7	31.0	29.9	28.5	27.4	26.6	25.9	25.0	23.8	22.2	20.0	17.3	14.1	10.3	6.3	
35	38.6	35.5	33.7	31.9	30.8	29.4	28.4	27.5	26.7	25.8	24.6	23.0	20.7	17.9	14.7	10.8	6.6	
36	39.8	36.5	34.6	32.8	31.6	30.3	29.2	28.4	27.6	26.6	25.4	23.7	21.4	18.6	15.3	11.3	6.9	
																		6

TABLE 27.—*Form or taper table for GREEN ASH trees of different diameters and heights, under 75 years in age, giving diameters inside bark at different heights above the ground.*

40-FOOT TREES.

Diameter breast-high.	Height above ground—feet.													Basis.
	1	2	3	4.5	9.15	17.3	25.45	33.6	41.75	49.9	58.05	66.2	74.35	82.5	
	Diameter inside bark—inches.														
Inches.															*Trees.*
4	5.2	4.6	4.2	3.5	3.0	2.3									6
5	6.4	5.8	5.3	4.4	3.7	2.9									7
6	7.6	6.9	6.3	5.3	4.2	3.4									2
7	8.7	8.0	7.3	6.3	4.8	3.9									6
8	9.9	9.1	8.4	7.2	5.4	4.4									4
9	11.1	10.3	9.4	8.2	6.0	4.9									
10	12.3	11.4	10.4	9.1	6.5	5.5									2
															27

50-FOOT TREES.

4	5.2	4.6	4.2	3.5	3.2	2.7	2.2							1
5	6.4	5.8	5.3	4.4	3.9	3.3	2.7							5
6	7.6	6.9	6.3	5.3	4.5	3.9	3.2							7
7	8.7	8.0	7.3	6.3	5.1	4.4	3.6							6
8	9.9	9.1	8.4	7.2	5.8	5.0	4.1							5
9	11.1	10.3	9.4	8.2	6.4	5.6	4.6							6
10	12.3	11.4	10.4	9.1	6.9	6.1	5.1							4
11	13.5	12.5	11.5	10.1	7.6	6.6	5.6							6
12	14.8	13.7	12.6	11.0	8.1	7.1	6.1							3
13	16.0	14.8	13.6	12.0	8.7	7.7	6.6							
14	17.2	15.9	14.7	13.0	9.3	8.2	7.0							
														43

60-FOOT TREES.

6	7.6	6.9	6.3	5.3	4.9	4.3	3.9	3.3	2.4						4
7	8.7	8.0	7.3	6.3	5.5	4.9	4.4	3.7	2.7						6
8	9.9	9.1	8.4	7.2	6.1	5.5	4.9	4.1	3.0						3
9	11.1	10.3	9.4	8.2	6.7	6.1	5.4	4.5	3.3						6
10	12.3	11.4	10.4	9.1	7.4	6.6	5.9	4.9	3.6						6
11	13.5	12.5	11.5	10.1	8.0	7.2	6.3	5.3	3.9						11
12	14.8	13.7	12.6	11.0	8.6	7.8	6.9	5.7	4.2						6
13	16.0	14.8	13.6	12.0	9.2	8.3	7.3	6.1	4.5						9
14	17.2	15.9	14.7	13.0	9.8	8.8	7.7	6.5	4.7						3
15	18.4	17.1	15.7	14.0	10.4	9.3	8.1	6.8	5.0						3
16	19.6	18.2	16.8	15.0	11.0	9.9	8.6	7.1	5.3						2
17	20.8	19.4	17.8	15.9	11.5	10.3	9.0	7.5	5.5						
18	22.0	20.5	18.9	16.9	12.1	10.9	9.4	7.8	5.9						2
19	23.3	21.7	20.0	17.9	12.7	11.3	9.7	8.1	6.1						1
20	24.5	22.8	21.1	18.9	13.3	11.8	10.2	8.5	6.4						
															62

70-FOOT TREES.

6	7.6	6.9	6.3	5.3	5.1	4.6	4.2	3.9	3.4	2.7					1
7	8.7	8.0	7.3	6.3	5.8	5.2	4.8	4.4	3.8	2.9					6
8	9.9	9.1	8.4	7.2	6.5	5.9	5.4	4.9	4.1	3.1					1
9	11.1	10.3	9.4	8.2	7.1	6.5	5.9	5.3	4.5	3.3					2
10	12.3	11.4	10.4	9.1	7.8	7.2	6.5	5.9	4.9	3.6					6
11	13.5	12.5	11.5	10.1	8.5	7.8	7.1	6.3	5.3	3.8					5
12	14.8	13.7	12.6	11.0	9.2	8.4	7.6	6.8	5.7	4.1					6
13	16.0	14.8	13.6	12.0	9.9	9.1	8.1	7.2	6.0	4.4					6
14	17.2	15.9	14.7	13.0	10.5	9.7	8.7	7.7	6.5	4.7					9
15	18.4	17.1	15.7	14.0	11.2	10.3	9.3	8.1	6.8	5.0					4
16	19.6	18.2	16.8	15.0	11.8	10.9	9.8	8.7	7.3	5.3					2
17	20.8	19.4	17.8	15.9	12.5	11.5	10.3	9.1	7.6	5.6					1
18	22.0	20.5	18.9	16.9	13.1	12.1	10.9	9.6	8.0	5.9					
19	23.3	21.7	20.0	17.9	13.7	12.7	11.4	10.1	8.4	6.2					1
20	24.5	22.8	21.1	18.9	14.3	13.2	12.0	10.5	8.8	6.5					
21	25.8	24.0	22.2	19.9	15.0	13.8	12.5	10.9	9.1	6.9					
22	27.1	25.2	23.3	20.9	15.6	14.4	13.0	11.5	9.5	7.2					1
23	28.3	26.3	24.4	21.9	16.2	14.9	13.6	11.9	9.9	7.5					
24	29.6	27.5	25.4	22.9	16.9	15.5	14.1	12.5	10.3	7.9					
															51

TABLE 27.—*Form or taper table for GREEN ASH trees of different diameters and heights, under 75 years in age, giving diameters inside bark at different heights above the ground*—Continued.

80-FOOT TREES.

Diameter breast-high.	Height above ground—feet.														Basis.
	1	2	3	4.5	9.15	17.3	25.45	33.6	41.75	49.9	58.05	66.2	74.35	82.5	
	Diameter inside bark—inches.														
Inches.															*Trees.*
8	9.9	9.1	8.4	7.2	6 8	6.2	5.8	5.4	4.7	3.7	2.5	1.5			
9	11.1	10.3	9.4	8.2	7.5	6.9	6.4	5.9	5.2	4.1	3.0	1.8			1
10	12.3	11.4	10.4	9.1	8.2	7.6	7.0	6.5	5.7	4.6	3.3	2.1			1
11	13.5	12.5	11.5	10.1	8.8	8.2	7.7	7.1	6.3	5.0	3.7	2.4			2
12	14.8	13.7	12.6	11.0	9.5	8.9	8.3	7.7	6.7	5.4	4.1	2.7			6
13	16.0	14.8	13.6	12.0	10.2	9.7	9.0	8.2	7.2	5.9	4.5	3.0			7
14	17.2	15.9	14.7	13.0	11.0	10.3	9.6	8.8	7.7	6.3	4.9	3.3			5
15	18.4	17.1	15.7	14.0	11.6	11.0	10.2	9.4	8.2	6.8	5.3	3.6			7
16	19.6	18.2	16.8	15.0	12.4	11.7	10.9	10.0	8.7	7.3	5.7	3.8			3
17	20.8	19.4	17.8	15.9	13.1	12.4	11.5	10.5	9.2	7.7	6.1	4.1			2
18	22.0	20.5	18.9	16.9	13.9	13.1	12.2	11.1	9.8	8.2	6.4	4.4			3
19	23.3	21.7	20.0	17.9	14.6	13.8	12.8	11.6	10.2	8.6	6.9	4.7			2
20	24.5	22.8	21.1	18.9	15.4	14.5	13.5	12.2	10.7	9.1	7.2	4.9			
21	25.8	24.0	22.2	19.9	16.2	15.1	14.1	12.8	11.2	9.5	7.6	5.1			1
22	27.1	25.2	23.3	20.9	17.0	15.8	14.7	13.3	11.7	10.0	8.0	5.5			
23	28.3	26 3	24.4	21.9	17.9	16.5	15.3	13.9	12.3	10.4	8.4	5.7			
24	29.6	27.5	25.4	22.9	18.7	17.3	15.9	14.5	12.8	10.9	8.8	6.1			
															40

90-FOOT TREES.

10	12.3	11.4	10.4	9.1	8.3	7.9	7.5	7.0	6.4	5.6	4.4	3.2	2.1		2
11	13.5	12.5	11.5	10.1	9.0	8.5	8.1	7.7	7.0	6.2	5.0	3.7	2.4		1
12	14.8	13.7	12.6	11.0	9.8	9.3	8.8	8.3	7.6	6.7	5.5	4.1	2.7		2
13	16.0	14.8	13.6	12.0	10.6	10.0	9.5	8.9	8.2	7.3	6.0	4.6	3.0		1
14	17.2	15.9	14.7	13.0	11.3	10.8	10.2	9.6	8.8	7.8	6.5	5.0	3.3		9
15	18.4	17.1	15.7	14.0	12.1	11.5	10.9	10.2	9.4	8.3	7.0	5.5	3.6		3
16	19.6	18.2	16.8	15.0	12.9	12.3	11.6	10.9	10.0	8.9	7.5	5.9	3.9		7
17	20.8	19.4	17.8	15.9	13.7	13.0	12.3	11.5	10.6	9.4	8.0	6.3	4.2		2
18	22.0	20.5	18.9	16.9	14.6	13.8	13.0	12.2	11.3	10.0	8.5	6.7	4.6		1
19	23.3	21.7	20.0	17.9	15.3	14.6	13.7	12.9	11.8	10.5	9.0	7.1	4.8		1

20	24.5	22.8	21.1	18.9	16.2	15.3	14.5	13.6	12.5	11.0	9.5	7.5	5.1	.....	1
21	25.8	24.0	22.2	19.9	17.0	16.1	15.2	14.3	13.1	11.5	9.9	7.9	5.3	.....	.....
22	27.1	25.2	23.3	20.9	17.9	16.9	15.9	14.9	13.7	12.1	10.3	8.3	5.6	.....	.....
23	28.3	26.3	24.4	21.9	18.7	17.6	16.6	15.6	14.3	12.7	10.8	8.6	5.9	.....	1
24	29.6	27.5	25.4	22.9	19.7	18.4	17.4	16.4	15.0	13.2	11.3	9.0	6.1	.....	1
															32

100-FOOT TREES.

10	12.3	11.4	10.4	9.1	8.4	8.1	7.8	7.3	6.9	6.2	5.3	4.2	3.0	1.9	.....
11	13.5	12.5	11.5	10.1	9.3	8.9	8.5	8.1	7.5	6.9	6.0	4.8	3.5	2.2	.....
12	14.8	13.7	12.6	11.0	10.0	9.7	9.3	8.8	8.3	7.6	6.6	5.3	3.9	2.5	1
13	16.0	14.8	13.6	12.0	10.9	10.4	10.0	9.5	8.9	8.3	7.2	5.9	4.4	2.9	.....
14	17.2	15.9	14.7	13.0	11.7	11.2	10.7	10.2	9.7	8.9	7.8	6.4	4.9	3.2	2
15	18.4	17.1	15.7	14.0	12.6	11.9	11.3	10.9	10.3	9.5	8.4	6.9	5.3	3.5	2
16	19.6	18.2	16.8	15.0	13.4	12.7	12.1	11.6	11.0	10.1	9.0	7.5	5.7	3.9	3
17	20.8	19.4	17.8	15.9	14.3	13.5	12.8	12.2	11.6	10.7	9.5	7.9	6.1	4.2	4
18	22.0	20.5	18.9	16.9	15.1	14.3	13.5	12.9	12.3	11.4	10.1	8.4	6.6	4.5	1
19	23.3	21.7	20.0	17.9	15.9	15.1	14.2	13.6	12.9	11.9	10.6	8.9	6.9	4.9	4
20	24.5	22.8	21.1	18.9	16.7	15.8	15.0	14.3	13.5	12.5	11.1	9.4	7.4	5.1	2
21	25.8	24.0	22.2	19.9	17.5	16.6	15.7	14.9	14.1	13.0	11.6	9.8	7.7	5.4	1
22	27.1	25.2	23.3	20.9	18.4	17.4	16.5	15.6	14.7	13.7	12.1	10.3	8.2	5.7	1
23	28.3	26.3	24.4	21.9	19.3	18.1	17.2	16.3	15.3	14.1	12.6	10.7	8.5	6.0	2
24	29.6	27.5	25.4	22.9	20.0	18.9	17.9	17.0	15.9	14.7	13.1	11.1	8.9	6.3	.....
															23

TABLE 28.—*Form or taper table for GREEN ASH trees of different diameters and heights, 75 to 149 years in age, giving diameters inside bark at different heights above the ground.*

60-FOOT TREES.

Diameter breast-high.	Height above ground—feet.																Basis.
	1	2	3	4.5	9.15	17.3	25.45	33.6	41.75	49.9	58.05	66.2	74.35	82.5	90.65	98.8	106.95	
	Diameter inside bark—inches.																	
Inches.																		*Trees.*
8	9.7	8.8	8.0	7.1	6.6	6.0	5.4	4.5	3.4	2.0	.....	.....	.....	.....	.....	.....	.....	2
9	10.9	10.0	9.1	8.1	7.4	6.6	6.0	5.0	3.8	2.3	.....	.....	.....	.....	.....	.....	.....	1
10	12.2	11.1	10.2	9.0	8.1	7.2	6.5	5.5	4.3	2.6	.....	.....	.....	.....	.....	.....	.....	1
11	13.4	12.2	11.2	10.0	8.8	7.8	7.1	6.0	4.6	2.8	.....	.....	.....	.....	.....	.....	.....	1
12	14.6	13.3	12.3	11.0	9.5	8.4	7.6	6.5	5.1	3.1	.....	.....	.....	.....	.....	.....	.....	.....
13	15.8	14.4	13.4	12.0	10.2	9.0	8.2	7.0	5.5	3.4	.....	.....	.....	.....	.....	.....	.....	2
14	17.0	15.6	14.5	12.9	10.9	9.6	8.7	7.4	5.8	3.7	.....	.....	.....	.....	.....	.....	.....	2
15	18.2	16.7	15.5	13.9	11.7	10.2	9.3	8.0	6.3	4.0	.....	.....	.....	.....	.....	.....	.....	1
16	19.4	17.9	16.6	14.9	12.4	10.8	9.8	8.4	6.7	4.4	.....	.....	.....	.....	.....	.....	.....	3
17	20.7	19.0	17.7	15.9	13.3	11.4	10.3	8.9	7.1	4.7	.....	.....	.....	.....	.....	.....	.....	.....
18	21.9	20.2	18.8	16.9	14.0	12.0	10.8	9.4	7.5	4.9	.....	.....	.....	.....	.....	.....	.....	.....
19	23.2	21.4	19.9	17.9	14.9	12.5	11.3	9.9	8.0	5.2	.....	.....	.....	.....	.....	.....	.....	.....
20	24.4	22.6	21.0	18.9	15.6	13.1	11.7	10.3	8.3	5.4	.....	.....	.....	.....	.....	.....	.....	.....
21	25.6	23.7	22.2	19.8	16.4	13.7	12.3	10.8	8.8	5.7	.....	.....	.....	.....	.....	.....	.....	2
22	26.9	24.9	23.3	20.8	17.2	14.2	12.8	11.3	9.1	6.0	.....	.....	.....	.....	.....	.....	.....	1
23	28.2	26.2	24.4	21.8	18.1	14.8	13.3	11.8	9.6	6.3	.....	.....	.....	.....	.....	.....	.....	.....
24	29.5	27.4	25.5	22.8	18.8	15.3	13.7	12.3	10.0	6.6	.....	.....	.....	.....	.....	.....	.....	.....
25	30.8	28.7	26.7	23.8	19.6	15.9	14.2	12.7	10.4	6.8	.....	.....	.....	.....	.....	.....	.....	.....
26	32.1	30.0	27.9	24.7	20.2	16.5	14.7	13.2	10.8	7.1	.....	.....	.....	.....	.....	.....	.....	1
																		17

70-FOOT TREES.

8	9.7	8.8	8.0	7.1	6.8	6.2	5.7	5.1	4.4	3.3	2.0	.....	.....	.....	.....	.....	.....	2
9	10.9	10.0	9.1	8.1	7.5	6.9	6.3	5.7	4.8	3.7	2.3	.....	.....	.....	.....	.....	.....	9
10	12.2	11.1	10.2	9.0	8.2	7.6	7.0	6.2	5.3	4.1	2.6	.....	.....	.....	.....	.....	.....	2
11	13.4	12.2	11.2	10.0	9.1	8.3	7.6	6.8	5.8	4.6	2.9	.....	.....	.....	.....	.....	.....	3
12	14.6	13.3	12.3	11.0	9.8	8.9	8.3	7.4	6.3	5.0	3.2	.....	.....	.....	.....	.....	.....	3
13	15.8	14.4	13.4	12.0	10.6	9.6	8.9	8.0	6.8	5.4	3.5	.....	.....	.....	.....	.....	.....	1
14	17.0	15.6	14.5	12.9	11.2	10.3	9.5	8.5	7.2	5.8	3.8	.....	.....	.....	.....	.....	.....	4
15	18.2	16.7	15.5	13.9	12.1	11.0	10.1	9.0	7.7	6.2	4.1	.....	.....	.....	.....	.....	.....	5
16	19.4	17.9	16.6	14.9	13.0	11.6	10.7	9.6	8.2	6.6	4.4	.....	.....	.....	.....	.....	.....	5
17	20.7	19.0	17.7	15.9	13.8	12.3	11.3	10.1	8.6	7.0	4.7	.....	.....	.....	.....	.....	.....	3
18	21.9	20.2	18.8	16.9	14.5	12.9	11.9	10.7	9.2	7.4	5.0	.....	.....	.....	.....	.....	.....	6
19	23.2	21.4	19.9	17.9	15.3	13.5	12.5	11.2	9.7	7.9	5.3	.....	.....	.....	.....	.....	.....	4
20	24.4	22.6	21.0	18.9	16.0	14.1	13.0	11.8	10.2	8.3	5.6	.....	.....	.....	.....	.....	.....	5

21	25.6	23.7	22.2	19.8	16.8	14.7	13.6	12.3	10.7	8.7	6.0							3
22	26.9	24.9	23.3	20.8	17.5	15.3	14.1	12.8	11.2	9.1	6.2							
23	23.2	26.2	24.4	21.8	18.3	15.8	14.6	13.3	11.6	9.5	6.6							
24	29.5	27.4	25.5	22.8	19.0	16.3	15.1	13.8	12.1	10.0	6.9							
25	30.8	28.7	26.7	23.8	19.7	16.9	15.6	14.3	12.6	10.4	7.3							1
26	32.1	30.0	27.9	24.7	20.4	17.4	16.0	14.8	13.1	10.8	7.6							
27	33.5	31.4	29.0	25.7	21.2	18.0	16.6	15.3	13.5	11.2	8.0							
28	34.8	32.8	30.2	26.7	21.9	18.4	17.0	15.8	14.0	11.5	8.3							
29	36.2	34.1	31.4	27.7	22.7	19.0	17.5	16.3	14.5	12.0	8.7							
30	37 7	35.5	32.6	28.6	23.4	19.5	18.0	16.8	14.9	12.4	9.0							1
31	39.2	36.9	33.7	29.6	24.3	20.1	18.5	17.4	15.4	12.8	9.5							
32	40.8	38.3	35.0	30.6	25.0	20.8	19.0	17.8	15.9	13.2	9.9							
																		57

80-FOOT TREES.

8	9.7	8.8	8.0	7.1	6.8	6.3	5.9	5.4	4.8	4.1	3.4	2.3						1
9	10.9	10.0	9.1	8.1	7.7	7.1	6.7	6.2	5.5	4.7	3.8	2.5						2
10	12.2	11.1	10.2	9.0	8.4	7.8	7.4	6.8	6.0	5.2	4.2	2.8						4
11	13.4	12.2	11.2	10.0	9.2	8.7	8.2	7.4	6.6	5.8	4.6	3.1						5
12	14.6	13.3	12.3	11.0	10.0	9.4	8.8	8.0	7.2	6.2	5.0	3.4						11
13	15.8	14.4	13.4	12.0	10.8	10.1	9.6	8.7	7.8	6.8	5.5	3.7						10
14	17.0	15.6	14.5	12.9	11.5	10.9	10.2	9.3	8.4	7.3	5.8	4.0						7
15	18.2	16.7	15.5	13.9	12.3	11.5	11.0	10.0	8.9	7.8	6.3	4.3						9
16	19.4	17.9	16.6	14.9	13.2	12.3	11.6	10.5	9.4	8.3	6.7	4.5						11
17	20.7	19.0	17.7	15.9	14.0	13.0	12.3	11.2	10.0	8.8	7.1	4.9						14
18	21.9	20.2	18.8	16.9	14.9	13.7	12.8	11.7	10.5	9.2	7.4	5.1						8
19	23.2	21.4	19.9	17.9	15.8	14.4	13.5	12.3	11.1	9.7	7.8	5.4						3
20	24.4	22.6	21.0	18.9	16.7	15.0	14.0	12.9	11.6	10.1	8.2	5.6						4
21	25.6	23.7	22.2	19.8	17.4	15.6	14.6	13.5	12.1	10.6	8.6	5.9						3
22	26.9	24.9	23.3	20.8	18.2	16.2	15.2	14.1	12.6	11.0	9.0	6.1						5
23	28.2	26.2	24.4	21.8	18.9	16.7	15.8	14.7	13.2	11.4	9.3	6.3						7
24	29.5	27.4	25.5	22.8	19.5	17.3	16.2	15.1	13.7	11.9	9.6	6.5						3
25	30.8	28.7	26.7	23.8	20.4	17.9	16.9	15.7	14.1	12.3	9.9	6.8						2
26	32.1	30.0	27.9	24.7	21.1	18.5	17.3	16.2	14.6	12.7	10.2	6.9						2
27	33.5	31.4	29.0	25.7	21.9	19.0	17.9	16.7	15.1	13.1	10.6	7.2						5
28	34.8	32.8	30.2	26.7	22.6	19.5	18.3	17.2	15.5	13.5	10.9	7.4						1
29	36.2	34.1	31.4	27.7	23.2	20.0	18.8	17.6	15.9	14.0	11.2	7.6						1
30	37.7	35.5	32.6	28.6	24.0	20.6	19.2	18.1	16.4	14.4	11.5	7.7						
31	39.2	36.9	33.7	29.6	24.7	21.1	19.7	18.5	16.8	14.8	11.8	7.9						1
32	40.8	38.3	35.0	30.6	25.5	21.6	20.1	19.0	17.3	15.2	12.1	8.1						
33	42.5	39.7	36.2	31.5	26.1	22.1	20.6	19.4	17.7	15.6	12.4	8.3						
34	44.4	41.2	37.5	32.5	26.8	22.5	21.0	19.8	18.2	16.0	12.7	8.4						1
35	46.3	42.7	38.8	33.5	27.4	23.0	21.4	20.3	18.6	16.4	13.0	8.6						
36	48.3	44.3	40.1	34.5	28.0	23.4	21.9	20.8	19.0	16.8	13.2	8.8						
37	50.5	45.9	41.4	35.4	28.9	24.2	22.4	21.3	19.5	17.1	13.5	9.0						1
38	52.9	47.6	42.7	36.4	29.8	24.8	22.9	21.7	19.9	17.5	13.8	9.1						1
																		122

TABLE 28.—*Form or taper table for GREEN ASH trees of different diameters and heights, 75 to 149 years in age, giving diameters inside bark at different heights above the ground*—Continued.

90-FOOT TREES.

Diameter breast-high.	Height above ground—feet.																	Basis.
	1	2	3	4.5	9.15	17.3	25.45	33.6	41.75	49.9	58.05	66.2	74.35	82.5	90.65	98.8	106.95	
	Diameter inside bark—inches.																	
Inches.																		*Trees.*
8	9.7	8.8	8.0	7.1	6.9	6.5	6.1	5.6	5.2	4.7	4.1	3.2	2.2					1
9	10.9	10.0	9.1	8.1	7.8	7.3	6.9	6.4	5.9	5.3	4.6	3.7	2.5					2
10	12.2	11.1	10.2	9.0	8.5	8.1	7.7	7.2	6.6	5.9	5.1	4.1	2.9					6
11	13.4	12.2	11.2	10.0	9.4	8.9	8.5	7.9	7.2	6.5	5.6	4.5	3.1					13
12	14.6	13.3	12.3	11.0	10.1	9.7	9.2	8.6	7.9	7.1	6.1	4.9	3.3					12
13	15.8	14.4	13.4	12.0	11.0	10.5	10.0	9.3	8.5	7.6	6.7	5.3	3.7					13
14	17.0	15.6	14.5	12.9	11.7	11.2	10.7	10.0	9.2	8.3	7.1	5.7	4.0					14
15	18.2	16.7	15.5	13.9	12.7	12.0	11.4	10.6	9.8	8.7	7.6	6.1	4.2					11
16	19.4	17.9	16.6	14.9	13.6	12.7	12.1	11.4	10.5	9.3	8.0	6.5	4.4					18
17	20.7	19.0	17.7	15.9	14.5	13.4	12.8	12.0	11.0	9.9	8.5	6.9	4.8					16
18	21.9	20.2	18.8	16.9	15.3	14.2	13.4	12.6	11.6	10.4	9.0	7.3	5.0					16
19	23.2	21.4	19.9	17.9	16.1	14.8	14.1	13.2	12.2	10.9	9.4	7.6	5.2					17
20	24.4	22.6	21.0	18.9	16.8	15.5	14.7	13.8	12.7	11.4	9.8	7.9	5.5					13
21	25.6	23.7	22.2	19.8	17.7	16.2	15.4	14.4	13.2	11.9	10.3	8.3	5.7					16
22	26.9	24.9	23.3	20.8	18.6	16.9	15.9	15.0	13.8	12.3	10.6	8.6	5.9					11
23	28.2	26.2	24.4	21.8	19.5	17.5	16.5	15.5	14.3	12.8	11.0	8.9	6.2					6
24	29.5	27.4	25.5	22.8	20.3	18.2	17.1	16.1	14.8	13.3	11.4	9.2	6.4					9
25	30.8	28.7	26.7	23.8	21.1	18.8	17.6	16.6	15.3	13.7	11.8	9.5	6.6					5
26	32.1	30.0	27.9	24.7	21.8	19.4	18.1	17.1	15.8	14.1	12.1	9.8	6.8					8
27	33.5	31.4	29.0	25.7	22.5	19.9	18.7	17.6	16.2	14.5	12.5	10.1	7.0					8
28	34.8	32.8	30.2	26.7	23.2	20.5	19.1	18.2	16.8	15.0	12.9	10.4	7.2					2
29	36.2	34.1	31.4	27.7	24.1	21.1	19.8	18.6	17.2	15.4	13.2	10.6	7.4					5
30	37.7	35.5	32.6	28.6	24.9	21.6	20.1	19.1	17.7	15.9	13.6	10.8	7.4					2
31	39.2	36.9	33.7	29.6	25.6	22.3	20.7	19.5	18.2	16.3	14.0	11.1	7.7					3
32	40.8	38.3	35.0	30.6	26.3	22.8	21.1	20.1	18.6	16.7	14.3	11.4	7.9					2
33	42.5	39.7	36.2	31.5	27.0	23.3	21.7	20.5	19.0	17.1	14.6	11.6	8.0					1
34	44.4	41.2	37.5	32.5	27.6	23.8	22.1	21.0	19.5	17.6	15.0	11.8	8.1					
35	46.3	42.7	38.8	33.5	28.4	24.3	22.5	21.4	19.9	18.0	15.3	12.0	8.2					
36	48.3	44.3	40.1	34.5	29.2	24.9	22.9	21.9	20.4	18.4	15.6	12.3	8.3					1
37	50.5	45.9	41.4	35.4	29.8	25.3	23.4	22.3	20.8	18.8	16.0	12.5	8.6					
38	52.9	47.6	42.7	36.4	30.3	25.8	23.8	22.7	21.3	19.2	16.3	12.8	8.8					
39	55.3	49.3	44.0	37.4	31.1	26.4	24.4	23.2	21.7	19.6	16.7	13.0	8.9					
40	57.8	51.0	45.4	38.3	31.9	27.0	24.9	23.7	22.1	20.0	17.0	13.2	8.9					
41	60.5	52.7	46.8	39.3	32.8	27.8	25.4	24.0	22.5	20.4	17.4	13.4	9.0					

42	63.4	54.5	48.2	40.3	33.8	28.6	25.9	24.3	22.9	20.9	17.6	13.6	9.2					
43	66.6	56.3	49.6	41.2	34.6	29.3	26.5	24.8	23.3	21.2	18.0	13.8	9.2					
44	70.1	58.1	50.9	42.2	35.6	30.0	27.0	25.2	23.7	21.6	18.3	14.0	9.4					
																		231

100-FOOT TREES.

10	12.2	11.1	10.2	9.0	8.6	8.2	7.8	7.4	7.0	6.6	6.0	5.2	4.1	2.9				1
11	13.4	12.2	11.2	10.0	9.5	9.0	8.8	8.3	7.8	7.1	6.5	5.6	4.4	3.1				3
12	14.6	13.3	12.3	11.0	10.2	9.9	9.5	8.9	8.4	7.8	7.0	6.0	4.8	3.3				3
13	15.8	14.4	13.4	12.0	11.2	10.6	10.3	9.7	9.0	8.3	7.5	6.4	5.1	3.6				8
14	17.0	15.6	14.5	12.9	12.0	11.4	10.9	10.3	9.6	8.9	8.0	6.9	5.5	3.8				10
15	18.2	16.7	15.5	13.9	12.9	12.2	11.8	11.0	10.3	9.5	8.5	7.3	5.8	4.0				13
16	19.4	17.9	16.6	14.9	13.7	13.0	12.5	11.8	11.0	10.0	9.0	7.8	6.2	4.3				16
17	20.7	19.0	17.7	15.9	14.6	13.8	13.3	12.6	11.6	10.6	9.5	8.1	6.5	4.6				13
18	21.9	20.2	18.8	16.9	15.5	14.5	13.9	13.1	12.1	11.1	10.0	8.6	6.8	4.8				18
19	23.2	21.4	19.9	17.9	16.4	15.2	14.6	13.7	12.8	11.7	10.5	9.0	7.2	5.1				25
20	24.4	22.6	21.0	18.9	17.2	16.0	15.2	14.3	13.3	12.2	10.9	9.3	7.4	5.3				18
21	25.6	23.7	22.2	19.8	18.1	16.7	15.9	15.0	13.9	12.7	11.4	9.7	7.8	5.5				13
22	26.9	24.9	23.3	20.8	18.8	17.3	16.4	15.6	14.5	13.2	11.8	10.1	8.1	5.8				10
23	28.2	26.2	24.4	21.8	19.7	17.9	17.1	16.2	15.1	13.7	12.2	10.5	8.4	6.0				15
24	29.5	27.4	25.5	22.8	20.6	18.7	17.7	16.9	15.6	14.2	12.6	10.8	8.7	6.2				18
25	30.8	28.7	26.7	23.8	21.4	19.3	18.2	17.3	16.1	14.6	13.0	11.2	9.1	6.4				10
26	32.1	30.0	27.9	24.7	22.2	20.0	18.8	17.8	16.6	15.1	13.5	11.6	9.3	6.7				10
27	33.5	31.4	29.0	25.7	23.0	20.6	19.4	18.3	17.0	15.6	13.9	11.9	9.6	6.9				7
28	34.8	32.8	30.2	26.7	23.8	21.3	20.0	18.9	17.7	16.1	14.3	12.3	9.9	7.1				11
29	36.2	34.1	31.4	27.7	24.7	21.9	20.5	19.5	18.1	16.6	14.7	12.6	10.2	7.3				4
30	37.7	35.5	32.6	28.6	25.4	22.5	21.0	20.0	18.7	17.0	15.1	13.0	10.5	7.5				7
31	39.2	36.9	33.7	29.6	26.2	23.0	21.5	20.5	19.2	17.5	15.5	13.3	10.7	7.7				7
32	40.8	38.3	35.0	30.6	27.1	23.8	22.1	21.0	19.7	17.9	15.9	13.6	10.9	7.9				1
33	42.5	39.7	36.2	31.5	27.8	24.2	22.6	21.5	20.2	18.4	16.3	13.9	11.2	8.0				2
34	44.4	41.2	37.5	32.5	28.5	24.8	23.1	22.0	20.6	18.8	16.7	14.2	11.4	8.2				1
35	46.3	42.7	38.8	33.5	29.5	25.4	23.6	22.5	21.1	19.3	17.1	14.6	11.8	8.3				2
36	48.3	44.3	40.1	34.5	30.3	26.1	24.0	23.0	21.6	19.7	17.5	14.9	12.0	8.5				1
37	50.5	45.9	41.4	35.4	30.9	26.6	24.6	23.4	22.0	20.2	17.9	15.2	12.3	8.7				1
38	52.9	47.6	42.7	36.4	31.3	27.1	25.1	24.0	22.5	20.6	18.2	15.6	12.5	8.9				
39	55.3	49.3	44.0	37.4	32.2	27.7	25.6	24.4	23.0	21.1	18.6	15.8	12.7	9.0				
40	57.8	51.0	45.4	38.3	32.9	28.3	26.1	25.0	23.5	21.5	19.0	16.1	12.9	9.2				
41	60.5	52.7	46.8	39.3	33.8	28.8	26.6	25.5	24.0	21.9	19.4	16.4	13.1	9.3				
42	63.4	54.5	48.2	40.3	34.5	29.5	27.1	26.0	24.4	22.4	19.8	16.8	13.4	9.5				
43	66.6	56.3	49.6	41.2	35.2	30.0	27.7	26.4	24.9	22.8	20.2	17.0	13.5	9.6				
44	70.1	58.1	50.9	42.2	35.7	30.5	28.2	27.0	25.3	23.3	20.5	17.3	13.8	9.8				
																		248

TABLE 28.—*Form or taper table for GREEN ASH trees of different diameters and heights, 75 to 149 years in age, giving diameters inside bark at different heights above the ground*—Continued.

110-FOOT TREES.

Diameter breast-high.	Height above ground—feet.																Basis.
	1	2	3	4.5	9.15	17.3	25.45	33.6	41.75	49.9	58.05	66.2	74.35	82.5	90.65	98.8	106.95	
	Diameter inside bark—inches.																
Inches.																		*Trees.*
12	14.6	13.3	12.3	11.0	10.5	10.1	9.7	9.4	8.9	8.3	7.7	6.9	6.0	4.8	3.3	1.9		
13	15.8	14.4	13.4	12.0	11.3	10.8	10.6	10.1	9.5	8.8	8.2	7.4	6.4	5.0	3.6	2.0		
14	17.0	15.6	14.5	12.9	12.1	11.6	11.3	10.7	10.1	9.4	8.7	7.7	6.7	5.4	3.8	2.2		2
15	18.2	16.7	15.5	13.9	13.0	12.4	12.0	11.4	10.7	10.0	9.1	8.2	7.1	5.6	4.0	2.3		8
16	19.4	17.9	16.6	14.9	13.7	13.1	12.7	12.0	11.3	10.5	9.5	8.5	7.4	5.9	4.2	2.4		1
17	20.7	19.0	17.7	15.9	14.7	13.9	13.5	12.7	11.9	11.0	10.0	8.9	7.7	6.2	4.4	2.5		7
18	21.9	20.2	18.8	16.9	15.5	14.7	14.1	13.3	12.5	11.6	10.5	9.3	8.1	6.4	4.6	2.7		10
19	23.2	21.4	19.9	17.9	16.4	15.4	14.8	14.0	13.0	12.1	11.1	9.8	8.4	6.7	4.8	2.8		16
20	24.4	22.6	21.0	18.9	17.2	16.1	15.4	14.5	13.6	12.6	11.5	10.1	8.7	7.0	5.1	2.9		9
21	25.6	23.7	22.2	19.8	18.1	16.9	16.2	15.2	14.2	13.1	12.0	10.6	9.1	7.3	5.3	3.1		9
22	26.9	24.9	23.3	20.8	18.8	17.6	16.8	15.8	14.7	13.6	12.4	11.0	9.4	7.5	5.5	3.2		16
23	28.2	26.2	24.4	21.8	19.8	18.3	17.4	16.4	15.3	14.1	12.9	11.5	9.8	7.8	5.7	3.4		12
24	29.5	27.4	25.5	22.8	20.6	19.0	18.0	16.9	15.8	14.6	13.4	11.8	10.1	8.1	6.0	3.6		13
25	30.8	28.7	26.7	23.8	21.5	19.7	18.7	17.6	16.4	15.2	13.9	12.2	10.4	8.4	6.2	3.7		9
26	32.1	30.0	27.9	24.7	22.2	20.3	19.2	18.1	16.9	15.7	14.3	12.6	10.8	8.7	6.4	3.8		10
27	33.5	31.4	29.0	25.7	23.0	20.9	19.9	18.7	17.5	16.2	14.8	13.1	11.2	9.0	6.6	3.9		11
28	34.8	32.8	30.2	26.7	23.8	21.6	20.5	19.3	18.1	16.7	15.2	13.4	11.6	9.3	6.8	4.0		9
29	36.2	34.1	31.4	27.7	24.7	22.2	21.1	20.0	18.6	17.2	15.7	13.9	11.8	9.6	7.0	4.1		8
30	37.7	35.5	32.6	28.6	25.6	22.9	21.6	20.5	19.2	17.8	16.2	14.2	12.2	9.8	7.2	4.2		8
31	39.2	36.9	33.7	29.6	26.4	23.6	22.3	21.1	19.7	18.3	16.6	14.7	12.6	10.1	7.4	4.3		8
32	40.8	38.3	35.0	30.6	27.2	24.2	22.8	21.7	20.3	18.7	17.0	15.0	12.9	10.4	7.6	4.4		3
33	42.5	39.7	36.2	31.5	28.0	24.9	23.5	22.2	20.8	19.2	17.5	15.5	13.2	10.6	7.8	4.5		6
34	44.4	41.2	37.5	32.5	28.7	25.5	24.1	22.9	21.3	19.7	17.9	15.8	13.5	10.8	7.9	4.7		
35	46.3	42.7	38.8	33.5	29.4	26.1	24.6	23.4	21.8	20.2	18.4	16.3	13.9	11.1	8.1	4.8		
36	48.3	44.3	40.1	34.5	30.0	26.7	25.3	24.0	22.4	20.7	18.8	16.6	14.2	11.4	8.3	4.9		2
37	50.5	45.9	41.4	35.4	30.8	27.4	25.9	24.5	23.0	21.3	19.2	17.1	14.5	11.6	8.5	5.0		1
38	52.9	47.6	42.7	36.4	31.8	28.0	26.4	25.1	23.5	21.8	19.8	17.4	14.8	11.9	8.6	5.1		1
39	55.3	49.3	44.0	37.4	32.7	28.7	27.0	25.6	24.0	22.3	20.3	17.8	15.1	12.1	8.8	5.2		
40	57.8	51.0	45.4	38.3	33.5	29.4	27.6	26.2	24.6	22.8	20.7	18.2	15.5	12.3	9.0	5.3		1
41	60.5	52.7	46.8	39.3	34.3	30.0	28.1	26.7	25.1	23.3	21.2	18.6	15.8	12.6	9.2	5.4		
42	63.4	54.5	48.2	40.3	35.1	30.7	28.7	27.3	25.7	23.8	21.6	19.0	16.1	12.9	9.3	5.5		
43	66.6	56.3	49.6	41.2	35.8	31.3	29.3	27.8	26.2	24.3	22.1	19.4	16.4	13.1	9.5	5.6		
44	70.1	58.1	50.9	42.2	36.5	32.0	29.9	28.4	26.7	24.9	22.5	19.7	16.7	13.3	9.7	5.7		1
																		131

14	17.0	15.6	14.5	12.9	12.1	11.7	11.5	10.9	10.4	9.8	9.1	8.2	7.2	6.1	4.9	3.4	1.9	1
15	18.2	16.7	15.5	13.9	13.0	12.5	12.2	11.6	11.0	10.3	9.5	8.6	7.6	6.4	5.1	3.6	2.0	.....
16	19.4	17.9	16.6	14.9	13.8	13.3	12.9	12.3	11.6	10.9	10.1	9.0	7.9	6.7	5.4	3.8	2.1	3
17	20.7	19.0	17.7	15.9	14.7	14.0	13.6	12.9	12.1	11.4	10.5	9.5	8.2	7.0	5.7	4.0	2.3	1
18	21.9	20.2	18.8	16.9	15.5	14.8	14.3	13.6	12.7	11.9	11.0	9.9	8.7	7.3	5.9	4.2	2.4	.....
19	23.2	21.4	19.9	17.9	16.4	15.5	15.0	14.2	13.3	12.5	11.6	10.4	9.1	7.7	6.2	4.5	2.5	3
20	24.4	22.6	21.0	18.9	17.3	16.3	15.6	14.8	13.9	13.0	12.1	10.8	9.5	8.0	6.5	4.7	2.6	4
21	25.6	23.7	22.2	19.8	18.1	17.0	16.3	15.4	14.5	13.6	12.6	11.3	9.9	8.4	6.8	4.9	2.7	5
22	26.9	24.9	23.3	20.8	18.9	17.7	16.9	16.0	15.0	14.1	13.0	11.7	10.3	8.7	7.1	5.1	2.9	6
23	28.2	26.2	24.4	21.8	19.9	18.4	17.6	16.6	15.5	14.6	13.6	12.2	10.6	9.0	7.3	5.3	3.0	5
24	29.5	27.4	25.5	22.8	20.7	19.1	18.2	17.3	16.2	15.2	14.0	12.6	11.0	9.3	7.6	5.5	3.1	6
25	30.8	28.7	26.7	23.8	21.5	19.8	18.9	17.9	16.8	15.8	14.6	13.0	11.4	9.6	7.8	5.7	3.2	2
26	32.1	30.0	27.9	24.7	22.3	20.5	19.5	18.5	17.4	16.3	15.0	13.4	11.8	9.9	8.0	5.9	3.4	4
27	33.5	31.4	29.0	25.7	23.2	21.2	20.2	19.1	17.9	16.8	15.5	13.9	12.1	10.2	8.3	6.0	3.5	1
28	34.8	32.8	30.2	26.7	24.0	21.9	20.8	19.8	18.5	17.3	16.0	14.3	12.6	10.6	8.6	6.2	3.6	6
29	36.2	34.1	31.4	27.7	25.0	22.7	21.5	20.4	19.1	17.9	16.5	14.8	12.9	10.9	8.8	6.4	3.7	.....
30	37.7	35.5	32.6	28.6	25.8	23.3	22.0	20.9	19.7	18.4	17.0	15.2	13.3	11.2	9.1	6.6	3.9	1
31	39.2	36.9	33.7	29.6	26.6	24.1	22.7	21.5	20.3	18.9	17.5	15.7	13.7	11.6	9.3	6.8	4.0	1
32	40.8	38.3	35.0	30.6	27.3	24.7	23.4	22.2	20.9	19.5	17.9	16.0	14.0	11.7	9.6	7.0	4.1	.....
33	42.5	39.7	36.2	31.5	28.1	25.5	24.0	22.8	21.5	20.0	18.4	16.5	14.3	12.1	9.8	7.2	4.2	.....
34	44.4	41.2	37.5	32.5	28.9	26.2	24.7	23.4	22.0	20.6	18.9	16.9	14.7	12.4	10.1	7.3	4.4	1
35	46.3	42.7	38.8	33.5	29.8	26.8	25.3	24.1	22.7	21.1	19.5	17.4	15.2	12.9	10.3	7.5	4.5	.....
36	48.3	44.3	40.1	34.5	30.8	27.7	26.0	24.6	23.3	21.8	20.1	17.9	15.6	13.1	10.6	7.7	4.6	.....
37	50.5	45.9	41.4	35.4	31.5	28.4	26.7	25.3	23.9	22.3	20.6	18.4	16.0	13.4	10.8	7.9	4.7	1
38	52.9	47.6	42.7	36.4	32.2	29.0	27.3	25.9	24.4	22.9	21.1	18.9	16.4	13.8	11.1	8.0	4.8	1
39	55.3	49.3	44.0	37.4	33.2	29.7	27.9	26.5	25.1	23.4	21.6	19.4	16.9	14.2	11.3	8.2	5.0	.....
40	57.8	51.0	45.4	38.3	34.0	30.4	28.6	27.2	25.6	24.0	22.2	19.8	17.2	14.5	11.6	8.4	5.1	.....
41	60.5	52.7	46.8	39.3	35.0	31.2	29.2	27.8	26.2	24.6	22.7	20.3	17.6	14.8	11.8	8.6	5.2	.....
42	63.4	54.5	48.2	40.3	35.9	31.9	29.9	28.4	26.8	25.2	23.2	20.8	18.1	15.1	12.0	8.8	5.3	.....
43	66.6	56.3	49.6	41.2	36.8	32.7	30.5	29.0	27.4	25.7	23.8	21.3	18.5	15.5	12.3	9.0	5.4	.....
44	70.1	58.1	50.9	42.2	37.5	33.4	31.2	29.6	28.0	26.3	24.3	21.7	18.8	15.7	12.6	9.1	5.6	.....
																		52

TABLE 28.—*Form or taper table for GREEN ASH trees of different diameters and heights, 75 to 149 years in age, giving diameters inside bark at different heights above the ground*—Continued.

130-FOOT TREES.

Diameter breast-high.	Height above ground—feet.																Basis.
	1	2	3	4.5	9.15	17.3	25.45	33.6	41.75	49.9	58.05	66.2	74.35	82.5	90.65	98.8	106.95	
	Diameter inside bark—inches.																	
Inches.																		*Trees.*
16	19.4	17.9	16.6	14.9	14.0	13.5	13.1	12.5	11.9	11.3	10.6	9.7	8.6	7.4	6.0	4.5	3.0	
17	20.7	19.0	17.7	15.9	14.8	14.2	13.8	13.2	12.5	11.7	11.0	10.0	9.0	7.8	6.3	4.7	3.2	
18	21.9	20.2	18.8	16.9	15.7	14.9	14.4	13.9	13.1	12.3	11.4	10.4	9.3	8.1	6.6	4.9	3.4	
19	23.2	21.4	19.9	17.9	16.6	15.7	15.1	14.4	13.6	12.8	11.9	10.8	9.7	8.5	6.8	5.1	3.6	1
20	24.4	22.6	21.0	18.9	17.5	16.4	15.7	15.1	14.3	13.3	12.3	11.2	10.1	8.7	7.1	5.4	3.7	
21	25.6	23.7	22.2	19.8	18.4	17.2	16.4	15.7	14.8	13.8	12.8	11.7	10.5	9.1	7.4	5.6	3.9	1
22	26.9	24.9	23.3	20.8	19.3	17.9	17.1	16.3	15.4	14.4	13.3	12.0	10.8	9.4	7.7	5.8	4.1	
23	28.2	26.2	24.4	21.8	20.1	18.6	17.7	16.9	16.0	14.9	13.8	12.5	11.2	9.8	7.9	6.1	4.3	2
24	29.5	27.4	25.5	22.8	20.9	19.4	18.5	17.6	16.6	15.4	14.3	12.9	11.5	10.1	8.3	6.3	4.4	3
25	30.8	28.7	26.7	23.8	21.8	20.0	19.1	18.2	17.2	16.0	14.8	13.4	12.0	10.5	8.6	6.6	4.6	1
26	32.1	30.0	27.9	24.7	22.5	20.8	19.8	18.8	17.8	16.6	15.2	13.8	12.4	10.8	8.9	6.8	4.8	
27	33.5	31.4	29.0	25.7	23.5	21.5	20.4	19.4	18.4	17.2	15.7	14.2	12.8	11.1	9.2	7.1	5.0	
28	34.8	32.8	30.2	26.7	24.3	22.3	21.1	20.1	19.1	17.7	16.2	14.7	13.1	11.5	9.5	7.4	5.2	
29	36.2	34.1	31.4	27.7	25.2	23.0	21.8	20.8	19.7	18.3	16.8	15.2	13.6	11.9	9.8	7.6	5.4	
30	37.7	35.5	32.6	28.6	26.0	23.8	22.5	21.5	20.4	18.9	17.3	15.7	14.0	12.2	10.1	7.8	5.6	
31	39.2	36.9	33.7	29.6	26.9	24.5	23.2	22.1	20.9	19.5	17.9	16.1	14.5	12.6	10.4	8.0	5.7	
32	40.8	38.3	35.0	30.6	27.7	25.3	23.9	22.8	21.6	20.1	18.4	16.7	14.8	12.9	10.7	8.3	5.9	1
33	42.5	39.7	36.2	31.5	28.7	26.1	24.6	23.5	22.2	20.7	19.0	17.2	15.3	13.3	11.1	8.6	6.1	
34	44.4	41.2	37.5	32.5	29.4	26.8	25.3	24.1	22.9	21.4	19.6	17.7	15.8	13.7	11.3	8.9	6.3	
35	46.3	42.7	38.8	33.5	30.3	27.6	26.0	24.8	23.5	21.9	20.2	18.3	16.3	14.1	11.7	9.1	6.6	
36	48.3	44.3	40.1	34.5	31.1	28.3	26.8	25.5	24.2	22.6	20.8	18.9	16.8	14.5	12.0	9.4	6.7	
37	50.5	45.9	41.4	35.4	32.0	29.1	27.5	26.2	24.8	23.2	21.5	19.5	17.3	15.0	12.4	9.6	6.9	
38	52.9	47.6	42.7	36.4	32.9	29.9	28.2	26.8	25.5	24.0	22.1	20.1	17.8	15.4	12.8	10.0	7.1	
39	55.3	49.3	44.0	37.4	33.8	30.7	29.0	27.6	26.1	24.5	22.7	20.6	18.3	15.8	13.2	10.2	7.3	
40	57.8	51.0	45.4	38.3	34.7	31.5	29.7	28.3	26.9	25.2	23.3	21.2	18.8	16.3	13.5	10.5	7.5	
41	60.5	52.7	46.8	39.3	35.6	32.3	30.5	29.1	27.5	25.8	23.9	21.8	19.4	16.7	13.8	10.8	7.7	
42	63.4	54.5	48.2	40.3	36.4	33.1	31.2	29.8	28.2	26.4	24.6	22.5	19.9	17.1	14.2	11.1	7.9	1
43	66.6	56.3	49.6	41.2	37.4	33.8	32.0	30.5	28.8	27.1	25.2	23.0	20.4	17.6	14.5	11.4	8.1	
44	70.1	58.1	50.9	42.2	38.2	34.6	32.7	31.2	29.5	27.7	25.8	23.6	20.9	18.0	14.9	11.7	8.3	

TABLE 29.—*Average total height, clear length, and used length, of GREEN ASH of different diameters of a large number of trees cut in South Carolina and Arkansas in 1905.*

Diameter, breast-high.	South Carolina.			Arkansas.		
	Total height.	Clear length.	Used length.	Total height.	Clear length.	Used length.
Inches.	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*
1	15	5	.....	13	6	.....
2	25	8	.....	22	10	.....
3	35	11	.....	30	14	.....
4	44	14	.....	38	18	.....
5	51	17	.....	46	22	.....
6	58	20	.....	54	25	.....
7	63	23	.....	61	29	.....
8	68	26	25	68	32	35
9	73	28	28	75	35	43
10	76	30	30	81	38	47
11	79	33	33	86	40	50
12	82	34	35	90	42	52
13	85	36	38	94	43	53
14	87	37	40	96	44	54
15	89	39	42	98	45	55
16	91	40	44	100	46	56
17	92	40	45	102	47	56
18	94	41	46	104	48	56
19	95	42	47	105	48	57
20	96	42	47	106	49	57
21	97	43	48	107	49	57
22	98	43	48	109	50	57
23	99	43	48	110	50	57
24	100	44	49	111	50	57
25	101	44	49	112	51	57
26	101	44	49	113	51	57
27	102	44	49	113	51	57
28	103	44	49	114	51	57
29	104	44	50	115	52	57
30	104	45	50	116	52	57
31	105	45	50	.....	.....	.....
32	106	45	50	.....	.....	.....
33	106	45	50	.....	.....	.....
34	107	45	50	.....	.....	.....
35	108	45	50	.....	.....	.....
36	108	45	50	.....	.....	.....
37	109	45	50	.....	.....	.....
38	110	45	50	.....	.....	.....
39	110	45	50	.....	.....	.....
40	111	45	50	.....	.....	.....

TABLE 30.—*Form or taper table for BLACK ASH trees of different diameters and heights, 75 to 300 years in age, giving diameters inside bark at different heights above the ground.*

60-FOOT TREES.

Diameter breast-high.	Height above ground—feet.																Basis.
	1	2	3	4.5	9.15	17.3	25.45	33.6	41.75	49.9	58.05	66.2	74.35	82.5	90.65	98.8	
	Diameter inside bark—inches.																
Inches.																	*Trees.*
6	7.6	6.2	5.7	5.5	5.2	4.7	4.0	3.3	2.5								
7	8.9	7.3	6.7	6.5	6.0	5.5	4.7	3.9	3.0						1		2
8	10.1	8.4	7.7	7.4	6.9	6.2	5.4	4.5	3.5								
9	11.4	9.5	8.7	8.3	7.8	7.0	6.2	5.2	4.0								
10	12.6	10.6	9.7	9.2	8.6	7.8	6.8	5.7	4.5								1
11	14.0	11.7	10.7	10.1	9.5	8.6	7.6	6.4	5.0								
12	15.3	12.8	11.7	11.0	10.3	9.4	8.2	6.9	5.5								
13	16.7	14.0	12.8	11.9	11.2	10.2	9.0	7.6	6.0								
14	18.1	15.1	13.9	12.8	12.0	10.9	9.5	8.2	6.5								
15	19.6	16.3	15.0	13.7	12.9	11.7	10.3	8.8	7.0								
16	21.0	17.4	16.0	14.6	13.7	12.4	11.0	9.4	7.5								
17	22.6	18.6	17.1	15.6	14.6	13.2	11.7	10.1	8.0								
18	24.1	19.8	18.2	16.5	15.4	13.9	12.4	10.6	8.5								
																	3

70-FOOT TREES.

6	7.6	6.2	5.7	5.5	5.2	4.7	4.3	3.8	3.1	2.2	1.2						
7	8.9	7.3	6.7	6.5	6.1	5.6	5.0	4.5	3.7	2.8	1.6						
8	10.1	8.4	7.7	7.4	6.9	6.4	5.8	5.1	4.3	3.2	1.9						4
9	11.4	9.5	8.7	8.3	7.8	7.1	6.5	5.8	5.0	3.8	2.3						5
10	12.6	10.6	9.7	9.2	8.7	7.9	7.2	6.5	5.6	4.3	2.6						5
11	14.0	11.7	10.7	10.2	9.6	8.8	8.0	7.2	6.2	4.8	3.0						3
12	15.3	12.8	11.7	11.1	10.4	9.6	8.7	7.9	6.9	5.4	3.4						7
13	16.7	14.0	12.8	12.0	11.3	10.3	9.5	8.6	7.5	6.0	3.7						8
14	18.1	15.1	13.9	12.9	12.2	11.3	10.3	9.3	8.2	6.6	4.1						2
15	19.6	16.3	15.0	13.8	13.1	12.0	11.1	10.1	8.9	7.2	4.5						1
16	21.0	17.4	16.0	14.7	14.0	12.9	11.9	10.8	9.6	7.8	4.9						1
17	22.6	18.6	17.1	15.7	14.9	13.8	12.7	11.5	10.3	8.4	5.2						1
18	24.1	19.8	18.2	16.6	15.7	14.6	13.5	12.3	11.0	8.9	5.5						

19	25.6	21.0	19.2	17.6	16.7	15.5	14.3	13.1	11.7	9.6	6.0						
20	27.2	22.2	20.3	18.6	17.6	16.4	15.2	14.0	12.5	10.2	6.3						1
21	28.7	23.4	21.4	19.6	18.6	17.4	16.1	14.7	13.2	10.8	6.8						1
22	30.3	24.7	22.5	20.6	19.5	18.2	16.9	15.5	13.9	11.5	7.1						
23	31.8	25.9	23.6	21.5	20.4	19.1	17.8	16.3	14.6	12.1	7.5						
24	33.4	27.2	24.6	22.5	21.3	20.0	18.6	17.1	15.3	12.6	7.8						
																	39

80-FOOT TREES.

6	7.6	6.2	5.7	5.5	5.1	5.0	4.6	4.1	3.5	2.8	2.0	1.1					
7	8.9	7.3	6.7	6.5	6.1	5.8	5.5	4.9	4.3	3.6	2.5	1.5					
8	10.1	8.4	7.7	7.4	7.0	6.6	6.2	5.6	5.0	4.2	3.0	1.7					
9	11.4	9.5	8.7	8.4	7.9	7.4	7.0	6.4	5.8	4.9	3.6	2.1					1
10	12.6	10.6	9.7	9.3	8.8	8.2	7.7	7.2	6.5	5.5	4.0	2.4					2
11	14.0	11.7	10.7	10.3	9.6	9.0	8.5	7.9	7.2	6.2	4.6	2.9					2
12	15.3	12.8	11.7	11.3	10.7	10.0	9.4	8.8	7.9	6.8	5.2	3.2					3
13	16.7	14.0	12.8	12.1	11.5	10.7	10.0	9.4	8.5	7.4	5.7	3.6					3
14	18.1	15.1	13.9	13.0	12.4	11.5	10.8	10.1	9.2	8.0	6.2	3.9					2
15	19.6	16.3	15.0	14.0	13.3	12.3	11.6	10.9	9.9	8.6	6.7	4.4					5
16	21.0	17.4	16.0	14.9	14.2	13.2	12.4	11.6	10.6	9.2	7.2	4.7					10
17	22.6	18.6	17.1	15.9	15.1	14.0	13.1	12.3	11.3	9.9	7.8	5.1					
18	24.1	19.8	18.2	16.7	16.0	14.8	13.8	13.0	11.9	10.5	8.3	5.5					5
19	25.6	21.0	19.2	17.7	17.0	15.7	14.7	13.8	12.7	11.2	8.9	5.9					3
20	27.2	22.2	20.3	18.6	17.8	16.5	15.4	14.4	13.3	11.8	9.4	6.2					1
21	28.7	23.4	21.4	19.6	18.6	17.2	16.2	15.2	14.0	12.5	10.1	6.7					
22	30.3	24.7	22.5	20.6	19.5	18.1	16.9	15.9	14.6	13.1	10.6	7.0					1
23	31.8	25.9	23.6	21.5	20.4	19.0	17.8	16.6	15.4	13.8	11.1	7.4					
24	33.4	27.2	24.6	22.5	21.3	19.8	18.5	17.3	16.0	14.4	11.7	7.8					
25	35.0	28.4	25.7	23.3	22.2	20.5	19.2	18.1	16.7	15.1	12.3	8.3					
26	36.7	29.7	26.8	24.3	23.0	21.3	20.0	18.7	17.3	15.7	12.8	8.5					
27	38.3	31.0	27.8	25.2	23.8	22.1	20.8	19.5	18.2	16.5	13.4	9.0					
28	39.9	32.2	28.9	26.2	24.7	22.9	21.4	20.2	18.7	17.0	13.9	9.3					
29	41.6	33.5	30.0	27.1	25.6	23.6	22.2	20.9	19.5	17.7	14.4	9.7					
30	43.2	34.7	31.1	28.0	26.4	24.4	22.9	21.5	20.0	18.3	15.0	10.0					
																	43

TABLE 30.—*Form or taper table for BLACK ASH trees of different diameters and heights, 75 to 300 years in age, giving diameters inside bark at different heights above the ground*—Continued.

90-FOOT TREES.

Diameter breast-high.	Height above ground—feet.																Basis.
	1	2	3	4.5	9.15	17.3	25.45	33.6	41.75	49.9	58.05	66.2	74.35	82.5	90.65	98.8	
	Diameter inside bark—inches.																
Inches.																	*Trees.*
12	15.3	12.8	11.7	11.4	10.9	10.2	9.7	9.3	8.6	7.6	6.4	5.0	3.3				
13	16.7	14.0	12.8	12.3	11.7	11.0	10.5	10.0	9.2	8.1	7.0	5.4	3.6				
14	18.1	15.1	13.9	13.2	12.6	11.8	11.3	10.7	9.8	8.8	7.5	5.9	3.9				
15	19.6	16.3	15.0	14.1	13.4	12.5	12.0	11.4	10.5	9.4	8.0	6.3	4.2				3
16	21.0	17.4	16.0	15.0	14.3	13.3	12.7	12.1	11.2	10.1	8.6	6.8	4.6				1
17	22.6	18.6	17.1	16.0	15.2	14.1	13.4	12.8	11.8	10.7	9.2	7.3	4.8				3
18	24.1	19.8	18.2	16.8	16.1	14.9	14.2	13.5	12.5	11.3	9.7	7.7	5.2				2
19	25.6	21.0	19.2	17.8	16.9	15.7	15.0	14.2	13.1	11.9	10.3	8.2	5.5				2
20	27.2	22.2	20.3	18.7	17.8	16.5	15.7	14.9	13.9	12.5	10.9	8.6	5.8				1
21	28.7	23.4	21.4	19.7	18.7	17.3	16.4	15.6	14.5	13.2	11.5	9.1	6.1				6
22	30.3	24.7	22.5	20.7	19.6	18.2	17.2	16.4	15.2	13.8	12.0	9.5	6.4				1
23	31.8	25.9	23.6	21.6	20.4	18.9	18.0	17.1	15.9	14.5	12.6	10.1	6.7				1
24	33.4	27.2	24.6	22.5	21.2	19.7	18.7	17.8	16.6	15.1	13.1	10.4	7.0				1
25	35.0	28.4	25.7	23.4	22.0	20.6	19.5	18.4	17.2	15.7	13.6	10.9	7.3				2
26	36.7	29.7	26.8	24.4	23.0	21.3	20.2	19.1	17.9	16.4	14.2	11.3	7.7				
27	38.3	31.0	27.8	25.3	23.8	22.1	21.0	19.8	18.5	17.0	14.8	11.8	7.9				
28	39.9	32.2	28.9	26.3	24.7	22.9	21.7	20.6	19.2	17.7	15.4	12.2	8.2				
29	41.6	33.5	30.0	27.2	25.5	23.7	22.5	21.3	20.0	18.4	15.9	12.5	8.5				1
30	43.2	34.7	31.1	28.1	26.4	24.6	23.3	22.0	20.7	19.0	16.4	13.0	8.8				
																	24

100-FOOT TREES.

16	21.0	17.4	16.0	15.0	14.3	13.4	12.8	12.3	11.5	10.6	9.5	8.0	6.0	3.8			
17	22.6	18.6	17.1	16.0	15.2	14.2	13.6	13.0	12.1	11.1	10.1	8.6	6.6	4.3			
18	24.1	19.8	18.2	16.9	16.1	15.0	14.4	13.7	12.8	11.8	10.7	9.2	7.1	4.7			
19	25.6	21.0	19.2	17.8	16.9	15.8	15.1	14.4	13.5	12.5	11.3	9.8	7.7	5.1			
20	27.2	22.2	20.3	18.7	17.8	16.6	15.8	15.1	14.2	13.2	11.9	10.3	8.2	5.6			
21	28.7	23.4	21.4	19.7	18.6	17.4	16.6	15.8	14.8	13.8	12.5	11.0	8.8	6.0			1
22	30.3	24.7	22.5	20.7	19.5	18.2	17.3	16.5	15.5	14.4	13.1	11.5	9.2	6.4			

23	31.8	25.9	23.6	21.6	20.3	19.0	18.1	17.3	16.1	14.9	13.6	12.0	9.8	6.8	.....	.....	.....
24	33.4	27.2	24.6	22.6	21.2	19.8	18.8	18.0	16.8	15.6	14.2	12.5	10.2	7.2	.....	.....	.....
25	35.0	28.4	25.7	23.5	22.0	20.5	19.6	18.7	17.5	16.2	14.8	13.1	10.7	7.6	.....	.....	.....
26	36.7	29.7	26.8	24.5	22.9	21.3	20.3	19.4	18.2	16.8	15.3	13.5	11.2	8.0	.....	.....	1
27	38.3	31.0	27.8	25.4	23.6	22.0	21.1	20.1	18.9	17.5	15.8	14.0	11.6	8.4	.....	.....	2
28	39.9	32.2	28.9	26.4	24.6	22.8	21.8	20.8	19.6	18.1	16.4	14.5	12.0	8.8	.....	.....	.....
29	41.6	33.5	30.0	27.3	25.5	23.7	22.5	21.5	20.3	18.7	17.0	14.9	12.4	9.2	.....	.....	.....
30	43.2	34.7	31.1	28.2	26.3	24.5	23.3	22.2	21.0	19.4	17.5	15.4	12.9	9.5	.....	.....	1
																	5

110-FOOT TREES.

20	27.2	22.2	20.3	18.7	17.8	16.4	15.6	15.1	14.3	13.4	12.6	11.9	10.8	9.0	6.9	4.3	.....
21	28.7	23.4	21.4	19.7	18.8	17.4	16.6	15.9	15.0	14.1	13.2	12.5	11.3	9.5	7.2	4.5	.....
22	30.3	24.7	22.5	20.7	19.6	18.1	17.3	16.7	15.8	14.8	13.8	13.0	11.8	10.1	7.6	4.7	.....
23	31.8	25.9	23.6	21.7	20.5	19.0	18.1	17.4	16.5	15.5	14.5	13.6	12.4	10.5	8.0	4.9	1
24	33.4	27.2	24.6	22.6	21.4	19.8	18.9	18.1	17.2	16.2	15.2	14.2	13.0	11.1	8.4	5.1	.....
25	35.0	28.4	25.7	23.6	22.2	20.6	19.7	19.0	17.9	16.7	15.8	14.8	13.6	11.6	8.8	5.4	.....
26	36.7	29.7	26.8	24.6	23.1	21.5	20.5	19.6	18.6	17.5	16.4	15.3	14.0	12.1	9.2	5.6	.....
27	38.3	31.0	27.8	25.5	24.1	22.4	21.2	20.3	19.2	18.1	16.9	15.8	14.6	12.6	9.6	5.8	.....
28	39.9	32.2	28.9	26.5	24.8	23.3	22.2	21.1	20.1	18.8	17.6	16.4	15.1	13.1	10.0	6.1	1
29	41.6	33.5	30.0	27.4	25.7	24.1	22.9	21.8	20.7	19.4	18.1	17.0	15.7	13.7	10.5	6.4	.....
30	43.2	34.7	31.1	28.4	26.6	24.8	23.6	22.5	21.2	20.0	18.7	17.5	16.2	14.2	10.9	6.7	.....
																	2

TABLE 31.—*Volume in cubic feet of stem wood, exclusive of bark, of WHITE ASH trees of different diameters and heights, under 75 years in age; and factors to multiply by to reduce to cubic feet including bark.*

Diameter breast-high.	Total height of tree—feet.								Factors to multiply by to reduce to cubic feet including bark.	Basis.
	20	30	40	50	60	70	80	90		
	Peeled volume—cubic feet.									
Inches.										*Trees.*
2	0.2	0.2	0.3	.....	.....	.....	.....	.....	.....	63
3	.4	.6	.8	.....	.....	.....	.....	.....	.....	47
4	.7	1.1	1.4	1.8	2.1	2.5	.....	.....	1.23	65
5	1.1	1.6	2.2	2.7	3.3	3.8	.....	.....	1.22	70
6	1.6	2.3	3.1	3.9	4.7	5.5	6.2	.....	1.22	81
7	.....	3.2	4.2	5.3	6.3	7.4	8.4	.....	1.21	57
8	.....	4.1	5.5	6.8	8.2	9.6	10.9	12.3	1.21	80
9	.....	5.1	6.9	8.6	10.3	12.0	13.7	15.4	1.20	57
10	.....	.....	8.6	10.7	12.9	15.0	17.2	19.3	1.20	63
11	.....	.....	10.3	12.9	15.4	18.0	21.0	23.0	1.20	54
12	.....	.....	12.3	15.4	18.5	22.0	25.0	28.0	1.19	45
13	.....	.....	.....	17.9	22.0	25.0	29.0	32.0	1.19	33
14	.....	.....	.....	21.0	25.0	29.0	33.0	38.0	1.18	28
15	.....	.....	.....	24.0	29.0	34.0	38.0	43.0	1.18	19
16	.....	.....	.....	27.0	33.0	38.0	44.0	49.0	1.18	14
17	.....	.....	.....	.....	37.0	43.0	49.0	55.0	1.17	10
18	.....	.....	.....	.....	41.0	48.0	55.0	62.0	1.17	6
19	.....	.....	.....	.....	46.0	54.0	61.0	69.0	1.17	6
20	.....	.....	.....	.....	51.0	60.0	68.0	77.0	1.16	3
21	.....	.....	.....	.....	56.0	66.0	75.0	85.0	1.16	4
22	.....	.....	.....	.....	62.0	72.0	82.0	93.0	1.16	1
										806

TABLE 32.—*Volume in cubic feet of stem wood, exclusive of bark, of WHITE ASH trees of different diameters and heights, 75 to 149 years in age; and factors to multiply by to reduce to cubic feet including bark.*

Diameter breast-high.	Total height of tree—feet.								Factors to multiply by to reduce to cubic feet including bark.	Basis.
	50	60	70	80	90	100	110	120		
	Peeled volume—cubic feet.									
Inches.										*Trees.*
6	4.0	4.8	5.6	.....	.....	.....	.....	.....	1.38	5
7	5.4	6.5	7.6	.....	.....	.....	.....	.....	1.36	8
8	7.0	8.4	9.8	11.2	.....	.....	.....	.....	1.34	13
9	8.8	10.6	12.3	14.1	.....	.....	.....	.....	1.32	23
10	11.0	13.2	15.4	17.6	19.8	.....	.....	.....	1.31	28
11	13.2	15.8	18.5	21.0	24.0	.....	.....	.....	1.30	42
12	15.8	19.0	22.0	25.0	28.0	32	.....	.....	1.28	49
13	18.4	22.0	26.0	29.0	33.0	37	.....	.....	1.27	46
14	21.0	26.0	30.0	34.0	39.0	43	47	.....	1.26	51
15	25.0	30.0	34.0	39.0	44.0	49	54	.....	1.25	32
16	28.0	34.0	39.0	45.0	50.0	56	62	67	1.24	51
17	32.0	38.0	44.0	51.0	57.0	63	70	76	1.23	30
18	35.0	42.0	50.0	57.0	64.0	71	78	85	1.22	24
19	39.0	47.0	55.0	63.0	71.0	79	87	95	1.21	21
20	44.0	52.0	61.0	70.0	78.0	87	96	105	1.20	17
21	48.0	58.0	67.0	77.0	87.0	96	106	116	1.19	10
22	53.0	63.0	74.0	84.0	95.0	106	116	127	1.18	11
23	.....	69.0	81.0	92.0	104.0	116	127	139	1.17	7
24	.....	75.0	88.0	100.0	113.0	126	138	151	1.17	1
25	.....	82.0	95.0	109.0	123.0	136	150	164	1.16	5
26	.....	89.0	103.0	118.0	133.0	148	162	177	1.15	2
27	.....	.....	111.0	127.0	143.0	159	175	191	1.15	2
28	.....	.....	120.0	137.0	154.0	171	188	205	1.14	2
29	.....	.....	129.0	147.0	165.0	184	202	220	1.14	3
30	.....	.....	137.0	157.0	177.0	196	216	236	1.13	1
31	.....	.....	.....	168.0	189.0	210	231	252	1.13	2
32	.....	.....	.....	179.0	201.0	224	246	268	1.12	1
33	.....	.....	.....	190.0	214.0	238	261	285	.....	.....
34	.....	.....	.....	202.0	227.0	252	278	303	.....	.....
35	.....	.....	.....	214.0	240.0	267	294	321	.....	1
36	.....	.....	.....	226.0	255.0	283	311	339	.....	.....
										488

TABLE 33.—*Volume of stem in cords,*[1] *including bark, of WHITE ASH under 75 years in age, for trees of different diameters and heights, and per cent of bark in trees of different diameters.*

[Based on taper table.]

Diameter breast-high.	Total height of tree—feet.								Bark.	Basis.
	20	30	40	50	60	70	80	90		
	Volume—cords.									
Inches.									*Per cent.*	*Trees.*
4	0.009	0.014	0.017	0.022	0.026	0.031	.....	.....	18.6	65
5	.013	.020	.027	.033	.040	.046	0.054	.....	18.3	70
6	.020	.028	.038	.048	.057	.067	.076	.....	17.9	81
7	.....	.039	.051	.064	.076	.090	.102	0.115	17.6	57
8	.....	.050	.067	.082	.099	.116	.132	.149	17.3	80
9	.....	.061	.083	.103	.124	.144	.164	.185	17.0	57
10	.....	.....	.103	.128	.155	.180	.206	.232	16.7	63
11	.....	.....	.124	.155	.185	.216	.247	.278	16.4	54
12	.....	.....	.146	.183	.220	.257	.293	.330	16.1	45
13	.....	.....	.....	.213	.256	.299	.342	.384	15.8	33
14	.....	.....	.....	.247	.295	.345	.394	.444	15.5	28
15	.....	.....	.....	.283	.340	.396	.453	.510	15.2	19
16	.....	.....	.....	.322	.387	.451	.516	.579	15.0	14
17	.....	.....	.....	.....	.433	.504	.577	.649	14.7	10
18	.....	.....	.....	.....	.484	.565	.646	.727	14.4	6
19	.....	.....	.....	.....	.539	.629	.720	.808	14.2	6
20	.....	.....	.....	.....	.592	.690	.789	.887	13.9	3
21	.....	.....	.....	.....	.654	.763	.872	.981	13.7	4
22	.....	.....	.....	.....	.717	.836	.956	1.075	13.5	1
										696

[1] To reduce to cubic feet, including stump, multiply the number of cords in each case by 100.

TABLE 34.—*Volume of stem in cords,*[1] *including bark, of WHITE ASH 75 to 149 years in age, for trees of different diameters and heights, and per cent of bark in trees of different diameters.*

[Based on taper table.]

Diameter breast-high.	Total height of tree—feet.								Bark.	Basis.
	50	60	70	80	90	100	110	120		
	Volume—cords.									
Inches.									*Per cent.*	*Trees.*
6	0.055	0.066	0.077	.....	.....	.....	.....	.....	27.3	5
7	.073	.088	.103	0.117	.....	.....	.....	.....	26.3	8
8	.094	.113	.131	.150	.....	.....	.....	.....	25.4	13
9	.116	.140	.162	.186	0.209	.....	.....	.....	24.5	23
10	.144	.173	.202	.231	.259	.....	.....	.....	23.6	28
11	.172	.205	.240	.274	.309	0.343	.....	.....	22.8	42
12	.202	.243	.283	.324	.364	.404	.....	.....	22.0	49
13	.234	.281	.328	.373	.420	.467	0.514	.....	21.2	46
14	.270	.324	.378	.431	.485	.539	.593	.....	20.5	51
15	.308	.369	.430	.492	.554	.615	.676	0.738	19.8	32
16	.347	.417	.486	.556	.625	.694	.764	.833	19.1	51
17	.389	.466	.544	.622	.700	.777	.855	.932	18.4	30
18	.432	.518	.605	.691	.777	.864	.950	1.037	17.7	24
19	.477	.572	.668	.762	.858	.953	1.049	1.145	17.1	21
20	.523	.628	.732	.838	.942	1.046	1.151	1.255	16.5	17
21	.574	.688	.803	.917	1.033	1.147	1.261	1.377	15.9	10
22	.623	.748	.872	.997	1.121	1.246	1.371	1.495	15.3	11
23	.....	.812	.947	1.082	1.217	1.353	1.488	1.623	14.8	7
24	.....	.882	1.028	1.176	1.322	1.470	1.617	1.763	14.3	1
25	.....	.949	1.108	1.266	1.424	1.582	1.740	1.899	13.8	5
26	.....	1.019	1.188	1.358	1.527	1.697	1.868	2.037	13.3	2
27	.....	.....	1.281	1.465	1.648	1.831	2.014	2.196	12.9	2
28	.....	.....	1.366	1.562	1.757	1.952	2.147	2.342	12.5	2
29	.....	.....	1.465	1.675	1.883	2.093	2.303	2.511	12.1	3
30	.....	.....	1.554	1.775	1.998	2.219	2.441	2.663	11.7	1
31	.....	.....	.....	1.895	2.131	2.368	2.606	2.842	11.4	2
32	.....	.....	.....	2.004	2.253	2.504	2.755	3.005	11.0	1
										487

[1] To reduce to cubic feet, including stump, multiply the number of cords in each case by 100.

TABLE 35.—*Average amount of branch wood 2 inches and over in diameter, in second-growth WHITE ASH trees of different diameters in New York, and the per cent which it forms of the total stem volume without the branches.*

Diameter breast-high.	Volume[1] of branch-wood.	Per cent of total stem volume.	Basis.	Diameter breast-high.	Volume[1] of branch-wood.	Per cent of total stem volume.	Basis.
Inches.	*Cubic feet.*	*Per cent.*	*Trees.*	*Inches.*	*Cubic feet.*	*Per cent.*	*Trees.*
8	0.2	2	16	16	5.7	11	10
9	.5	4	11	17	7.0	12	2
10	1.0	6	20	18	8.4	13	5
11	1.5	7	18	19	10.0	14	.....
12	2.1	8	21	20	11.6	14	5
13	2.8	9	15				
14	3.6	9	9				144
15	4.6	10	12				

[1] To reduce to cords divide by 100.

TABLE 36.—*Volume in board feet of WHITE ASH, under 75 years in age, for trees of different diameters and number of logs, scaled by the Scribner log rule.*

[Based on taper curves; scaled mostly in 16.3-foot logs, with a few shorter logs where necessary. Height of stump, 1 foot. Measurements taken in Vermont, New York, Michigan, Indiana, and Tennessee.]

Diameter breast-high.	Number of 16-foot logs.								Diameter inside bark of top.	Basis.
	1½	2	2½	3	3½	4	4½	5		
	Volume—board feet.									
Inches.									*Inches.*	*Trees.*
8	25	38	50	.....	.....	.....	.....	.....	6	80
9	27	41	54	72	.....	.....	.....	.....	6	57
10	30	44	60	79	100	.....	.....	.....	6	63
11	32	48	67	88	110	.....	.....	.....	6	54
12	35	54	75	100	120	150	.....	.....	6	45
13	.....	62	85	110	140	170	.....	.....	6	33
14	.....	70	95	120	150	190	220	.....	6	28
15	.....	80	110	140	170	210	240	.....	6	19
16	.....	92	120	150	190	230	270	.....	6	14
17	.....	.....	140	170	210	250	300	.....	6	10
18	.....	.....	150	190	230	280	330	380	6	6
19	.....	.....	170	220	260	310	370	420	6	6
20	.....	.....	200	240	290	350	410	470	6	3
21	.....	.....	220	270	320	390	450	520	7	4
22	.....	.....	240	300	360	430	490	570	7	1
23	.....	.....	270	330	390	470	540	620	8	.....
24	.....	.....	300	370	430	510	580	670	8	.....
										423

TABLE 37.—*Volume in board feet of WHITE ASH, 75 to 149 years in age, for trees of different diameters and number of logs, scaled by the Scribner log rule.*

[Based on taper curves; scaled mostly in 16.3-foot logs, with a few shorter logs where necessary. Height of stump, 1 foot. Measurements taken in New Hampshire, Vermont, New York, Indiana, Tennessee, West Virginia, and North Carolina.]

Diameter breast-high.	Number of 16-foot logs.									Diameter inside bark of top.	Basis.
	2	2½	3	3½	4	4½	5	5½	6		
	Volume—board feet.										
Inches.										*Inches.*	*Trees.*
8	32	43	51	69						6	13
9	37	50	60	80						6	23
10	42	58	70	91						6	28
11	49	68	80	100						6	42
12	57	78	93	120	140					6	49
13	66	90	110	130	160					6	46
14	77	100	120	150	180	200	230			6	51
15	90	120	140	170	200	230	260			6	32
16	100	130	160	190	220	260	290	330	370	6	51
17	120	150	180	210	250	290	330	370	410	6	30
18	130	170	200	240	280	320	370	410	460	6	24
19	150	190	230	270	320	360	420	460	520	6	21
20	170	210	250	300	360	410	470	520	590	6	17
21	190	230	280	340	400	460	520	590	660	7	10
22	210	260	310	380	450	510	590	660	750	7	11
23		290	350	420	500	580	660	750	840	8	7
24		320	380	460	550	650	740	840	940	9	1
25		350	420	510	610	730	830	940	1,050	9	5
26		380	460	570	680	810	920	1,050	1,170	10	2
27		410	510	630	760	890	1,020	1,160	1,300	10	2
28		450	560	690	840	980	1,130	1,280	1,440	11	2
29		480	610	760	920	1,070	1,240	1,410	1,590	11	3
30		520	660	830	1,010	1,170	1,360	1,550	1,750	12	1
31			720	900	1,100	1,280	1,490	1,690	1,910	13	2
32			790	990	1,190	1,390	1,620	1,850	2,080	13	1
33			860	1,070	1,290	1,510	1,760	2,020	2,260	14	
34			930	1,160	1,400	1,640	1,910	2,200	2,470	14	
35			1,000	1,250	1,500	1,760	2,050	2,380	2,690	15	1
36			1,080	1,340	1,610	1,890	2,210	2,560	2,900	16	
37			1,160	1,440	1,720	2,020	2,360	2,740	3,120	16	
38			1,240	1,540	1,830	2,160	2,520	2,930	3,350	17	
39			1,320	1,650	1,950	2,310	2,690	3,130	3,620	17	
40			1,410	1,760	2,060	2,470	2,870	3,340	3,900	18	
											475

TABLE 38.—*Volume in cubic feet of stem wood, exclusive of bark, of GREEN ASH trees of different diameters and heights, under 75 years in age, and factors to multiply by to reduce to cubic feet, including bark.*

Diameter breast-high.	Total height of tree—feet.							Factors to multiply by to reduce to cubic feet, including bark.	Basis.
	40	50	60	70	80	90	100		
	Peeled volume—cubic feet.								
Inches.									*Trees.*
4	1.4	1.8						1.29	7
5	2.0	2.7						1.28	12
6	2.8	3.7	4.6	5.5				1.27	14
7	3.7	4.8	6.0	7.2				1.25	24
8	4.6	6.0	7.6	9.1	10.9			1.24	13
9	5.7	7.4	9.2	11.1	13.4			1.23	15
10	7.0	9.1	11.2	13.5	16.3	19.3	22	1.22	21
11		10.7	13.3	15.9	19.3	23.0	26	1.21	25
12		12.6	15.6	18.8	23.0	27.0	32	1.20	24
13		14.5	17.9	22.0	26.0	31.0	37	1.19	23
14		16.6	21.0	25.0	30.0	37.0	43	1.18	28
15			23.0	28.0	34.0	42.0	49	1.17	19
16			26.0	32.0	39.0	48.0	56	1.17	17
17			29.0	36.0	44.0	53.0	63	1.16	9
18			32.0	40.0	50.0	59.0	71	1.15	7
19			35.0	44.0	55.0	66.0	79	1.15	9
20			38.0	49.0	61.0	73.0	87	1.14	3
21				53.0	67.0	80.0	96	1.14	2
22				57.0	72.0	88.0	106	1.13	2
23				63.0	79.0	96.0	116	1.13	3
24				68.0	85.0	105.0	126	1.12	1
									278

TABLE 39.—*Volume in cubic feet of stem wood, exclusive of bark, of GREEN ASH trees of different diameters and heights, 75 to 149 years in age, and factors to multiply by to reduce to cubic feet, including bark.*

Diameter breast-high.	Total height of tree—feet.								Factors to multiply by to reduce to cubic feet, including bark.	Basis.
	60	70	80	90	100	110	120	130		
	Peeled volume—cubic feet.									
Inches.										*Trees.*
8	8.6	10.0	11.5	12.9	.....	.....	.....	.....	1.27	6
9	10.7	12.5	14.3	16.0	.....	.....	.....	.....	1.26	14
10	13.2	15.4	17.6	19.8	22	.....	.....	.....	1.25	14
11	15.8	18.5	21.0	24.0	26	.....	.....	.....	1.24	25
12	19.0	22.0	25.0	28.0	32	35	.....	.....	1.22	29
13	22.0	26.0	29.0	33.0	37	40	.....	.....	1.21	34
14	26.0	30.0	34.0	39.0	43	47	51	.....	1.20	40
15	29.0	34.0	39.0	44.0	49	53	58	.....	1.19	47
16	33.0	38.0	44.0	49.0	55	60	66	71	1.19	57
17	37.0	43.0	49.0	55.0	62	68	74	80	1.18	54
18	41.0	48.0	55.0	62.0	69	76	83	90	1.17	58
19	46.0	53.0	61.0	68.0	76	83	91	99	1.16	69
20	50.0	58.0	66.0	75.0	83	91	99	108	1.15	53
21	54.0	63.0	72.0	81.0	90	99	108	117	1.15	52
22	59.0	68.0	78.0	88.0	98	107	117	127	1.14	49
23	64.0	75.0	86.0	96.0	107	118	128	139	1.14	47
24	70.0	81.0	93.0	105.0	116	128	139	151	1.13	52
25	75.0	87.0	100.0	112.0	124	137	149	162	1.13	30
26	80.0	93.0	106.0	120.0	133	146	159	173	1.13	35
27	.....	100.0	115.0	129.0	143	158	172	186	1.12	32
28	.....	108.0	123.0	139.0	154	169	185	200	1.12	29
29	.....	114.0	130.0	147.0	163	179	196	212	1.12	18
30	.....	120.0	137.0	155.0	172	189	206	223	1.12	19
31	.....	128.0	147.0	165.0	183	202	220	238	1.12	20
32	.....	137.0	157.0	176.0	196	215	235	254	1.11	7
33	.....	.....	166.0	187.0	208	229	249	270	1.11	9
34	.....	.....	177.0	199.0	221	243	265	287	1.11	3
35	.....	.....	184.0	207.0	230	254	277	300	1.11	2
36	.....	.....	192.0	216.0	240	264	288	312	1.11	4
37	.....	.....	203.0	229.0	254	279	305	330	1.11	4
38	.....	.....	214.0	241.0	268	295	322	348	1.11	3
39	.....	.....	.....	254.0	282	310	339	367	1.11	.....
40	.....	.....	.....	267.0	297	327	356	386	1.11	1
41	.....	.....	.....	281.0	312	343	374	405	1.11	.....
42	.....	.....	.....	294.0	327	360	392	425	1.11	1
43	.....	.....	.....	308.0	343	377	411	446	1.11	.....
44	.....	.....	.....	323.0	359	395	431	467	1.11	1
										918

TABLE 40.—*Volume of stem in cords,*[1] *including bark, of GREEN ASH, under 75 years in age, for trees of different diameters and heights, and per cent of bark in trees of different diameters.*

[Based on taper table.]

Diameter breast-high.	Total height of tree—feet.							Bark.	Basis.
	40	50	60	70	80	90	100		
	Volume—cords.								
Inches.								*Per cent.*	*Trees.*
4	0.018	0.024						22.4	7
5	.026	.035						21.7	12
6	.036	.047	0.058	0.070				21.0	14
7	.046	.060	.075	.090				20.2	24
8	.057	.074	.094	.113	0.135			19.4	13
9	.070	.091	.113	.137	.165			18.6	15
10	.085	.111	.137	.165	.199	0.235	0.268	17.9	21
11		.129	.161	.192	.234	.277	.319	17.2	25
12		.151	.187	.226	.274	.324	.379	16.5	24
13		.173	.213	.257	.311	.375	.438	15.8	23
14		.196	.242	.291	.354	.432	.505	15.3	28
15			.271	.332	.402	.493	.576	14.8	19
16			.304	.378	.459	.560	.655	14.3	17
17			.335	.416	.513	.618	.733	13.8	9
18			.367	.455	.570	.677	.814	13.4	7
19			.401	.507	.635	.754	.906	13.0	9
20			.432	.556	.695	.828	.994	12.6	3
21				.605	.758	.915	1.099	12.2	2
22				.647	.811	.993	1.193	11.8	2
23				.709	.888	1.087	1.306	11.4	3
24				.763	.956	1.172	1.407	11.1	1
									278

[1] To reduce to cubic feet, including stump, multiply the number of cords in each case by 100.

TABLE 41.—*Volume of stem in cords,*[1] *including bark, of GREEN ASH, 75 to 149 years in age, for trees of different diameters and heights, and per cent of bark in trees of different diameters.*

[Based on taper table.]

Diameter breast-high.	Total height of tree—feet.								Bark.	Basis.
	60	70	80	90	100	110	120	130		
	Volume—cords.									
Inches.									*Per cent.*	*Trees.*
8	0.109	0.127	0.146	0.164					21.5	6
9	.135	.158	.180	.202	0.224				20.7	14
10	.165	.192	.220	.248	.275				19.9	14
11	.196	.229	.262	.295	.327	0.360			19.1	25
12	.232	.270	.309	.346	.386	.425			18.3	29
13	.267	.312	.356	.401	.445	.490	0.535		17.6	34
14	.308	.360	.410	.462	.514	.565	.617		16.9	40
15	.347	.405	.463	.520	.578	.635	.694	0.752	16.3	47
16	.390	.455	.520	.584	.650	.715	.779	.845	15.7	57
17	.437	.509	.582	.655	.727	.800	.872	.945	15.1	54
18	.484	.565	.646	.727	.807	.888	.969	1.049	14.5	58
19	.528	.616	.704	.792	.879	.967	1.056	1.144	14.0	69
20	.572	.667	.762	.858	.952	1.048	1.143	1.239	13.4	53
21	.623	.728	.831	.935	1.040	1.143	1.247	1.351	12.9	52
22	.668	.780	.890	1.002	1.114	1.224	1.336	1.448	12.5	49
23	.732	.854	.975	1.097	1.219	1.341	1.463	1.585	12.1	47
24	.788	.919	1.050	1.182	1.313	1.444	1.575	1.706	11.7	52
25	.844	.984	1.125	1.266	1.407	1.547	1.688	1.828	11.4	30
26	.901	1.051	1.201	1.351	1.501	1.651	1.801	1.952	11.2	35
27		1.123	1.284	1.445	1.605	1.765	1.925	2.087	10.9	32
28		1.208	1.381	1.553	1.726	1.898	2.071	2.243	10.8	29
29		1.278	1.460	1.643	1.824	2.007	2.190	2.372	10.6	18
30		1.347	1.540	1.733	1.924	2.117	2.309	2.502	10.5	19
31		1.438	1.643	1.849	2.054	2.259	2.465	2.670	10.4	20
32		1.521	1.737	1.955	2.171	2.389	2.606	2.823	10.3	7

[1] To reduce to cubic feet, including stump, multiply the number of cords in each case by 100.

TABLE 41.—*Volume of stem in cords, including bark, of GREEN ASH, 75 to 149 years in age, etc.*—Continued.

Diameter breast-high.	Total height of tree—feet.								Bark.	Basis.
	60	70	80	90	100	110	120	130		
	Volume—cords.									
Inches.									*Per cent.*	*Trees.*
33	.....	.....	1.846	2.077	2.308	2.539	2.769	3.000	10.2	9
34	.....	.....	1.961	2.207	2.452	2.696	2.942	3.187	10.1	3
35	.....	.....	2.047	2.302	2.559	2.814	3.070	3.326	10.1	2
36	.....	.....	2.135	2.401	2.668	2.935	3.202	3.469	10.1	4
37	.....	.....	2.256	2.537	2.819	3.101	3.383	3.665	10.0	4
38	.....	.....	2.379	2.676	2.974	3.271	3.569	3.866	10.0	3
39	.....	.....	.....	2.819	3.132	3.445	3.758	4.073	10.0	.....
40	.....	.....	.....	2.965	3.294	3.624	3.954	4.283	10.0	1
41	.....	.....	.....	3.115	3.461	3.807	4.153	4.499	10.0	.....
42	.....	.....	.....	3.268	3.631	3.994	4.357	4.720	10.0	1
43	.....	.....	.....	3.423	3.804	4.185	4.565	4.945	10.0	.....
44	.....	.....	.....	3.586	3.985	4.383	4.782	5.181	10.0	1
										918

TABLE 42.—*Volume in board feet of GREEN ASH, under 75 years in age, for trees of different diameters, and number of logs, scaled by the Scribner log rule.*

[Based on taper curves; scaled mostly in 16.3-foot logs, with a few shorter logs where necessary. Height of stump, 1 foot. Measurements taken in South Carolina and Arkansas.]

Diameter breast-high.	Number of 16-foot logs.									Diameter inside bark of top.	Basis.
	1	1½	2	2½	3	3½	4	4½	5		
	Volume—board feet.										
Inches.										*Inches.*	*Trees.*
8	15	24	36	.....	.....	.....	.....	.....	.....	6	13
9	16	26	38	51	.....	.....	.....	.....	.....	6	16
10	17	27	41	56	75	.....	.....	.....	.....	6	21
11	18	29	44	62	82	110	.....	.....	.....	6	25
12	20	31	47	67	90	120	150	.....	.....	6	24
13	22	33	50	72	100	130	160	200	.....	6	23
14	23	35	54	78	110	140	180	210	250	6	28
15	.....	38	58	86	120	150	190	230	270	6	19
16	.....	42	63	95	130	170	210	260	300	6	17
17	.....	.....	69	100	140	190	230	280	330	6	9
18	.....	.....	75	110	160	200	250	310	360	6	7
19	.....	.....	.....	120	170	220	280	340	410	6	9
20	.....	.....	.....	130	180	250	310	380	460	6	3
21	.....	.....	.....	140	200	270	350	430	510	7	2
22	.....	.....	.....	150	220	300	390	490	580	7	2
23	.....	.....	.....	.....	240	340	440	550	650	8	3
24	.....	.....	.....	.....	260	370	490	610	730	8	1
25	.....	.....	.....	.....	280	410	550	680	810	9	1
26	.....	.....	.....	.....	300	450	600	750	900	10	.....
											223

TABLE 43.—*Volume in board feet of GREEN ASH, 75 to 149 years in age, for trees of different diameters and number of logs, scaled by the Scribner log rule.*

[Based on taper curves; scaled mostly in 16.3-foot logs, with a few shorter logs where necessary. Height of stump, 1 foot. Measurements taken in South Carolina and Arkansas.]

Diameter breast-high.	Number of 16-foot logs.									Diameter inside bark of top.	Basis.
	2	2½	3	3½	4	4½	5	5½	6		
	Volume—board feet.										
Inches.										*Inches.*	*Trees.*
8	37	47	56	.....	.....	.....	.....	.....	.....	6	6
9	40	52	65	.....	.....	.....	.....	.....	.....	6	14
10	43	57	74	88	100	120	130	.....	.....	6	14
11	45	63	83	100	120	140	160	.....	.....	6	25
12	48	69	92	110	140	160	180	.....	.....	6	29
13	50	74	100	130	160	180	210	.....	.....	6	34
14	53	80	110	140	170	210	240	270	300	6	40
15	56	86	120	160	190	230	270	300	340	6	47
16	59	93	130	170	220	260	300	340	380	6	57
17	62	100	140	190	240	280	330	380	420	6	54
18	66	110	160	210	260	310	370	420	470	6	58
19	71	120	170	230	290	350	410	460	520	6	69
20	77	130	190	260	320	390	450	510	580	6	53
21	84	140	210	280	360	430	500	570	640	7	52
22	92	160	240	310	400	480	550	630	710	7	49
23	100	180	260	350	440	530	610	690	780	8	47
24	120	200	290	390	490	590	670	770	860	8	52
25	130	220	330	430	540	650	740	850	940	9	30
26	140	240	360	480	600	710	810	930	1,030	10	35
27	160	270	400	530	660	780	890	1,020	1,120	10	32
28	180	300	450	590	730	860	980	1,110	1,220	11	29
29	200	330	490	650	800	940	1,080	1,210	1,330	11	18
30	220	370	530	710	870	1,020	1,180	1,330	1,460	12	19
31	.....	400	580	770	950	1,110	1,290	1,450	1,620	13	20
32	.....	440	630	830	1,030	1,210	1,410	1,600	1,800	13	7
33	.....	480	680	900	1,110	1,320	1,540	1,750	1,980	14	9
34	.....	510	730	970	1,200	1,430	1,670	1,900	2,150	14	3
35	.....	550	790	1,050	1,290	1,540	1,800	2,050	2,320	15	2
36	.....	590	840	1,120	1,380	1,660	1,930	2,200	2,490	16	4
37	.....	.....	900	1,190	1,480	1,770	2,060	2,350	2,650	16	4
38	.....	.....	960	1,270	1,580	1,890	2,200	2,500	2,820	17	3
39	.....	.....	1,010	1,350	1,680	2,000	2,340	2,650	3,000	17	.....
40	.....	.....	1,070	1,420	1,780	2,120	2,480	2,810	3,180	18	1
41	.....	.....	1,130	1,500	1,880	2,250	2,630	2,990	3,370	19	.....
42	.....	.....	1,190	1,580	1,990	2,380	2,780	3,170	3,570	19	1
43	.....	.....	1,260	1,660	2,090	2,520	2,950	3,380	3,790	20	.....
44	.....	.....	1,320	1,750	2,200	2,660	3,130	3,610	4,000	20	1
											918

TABLE 44.—*Volume in cubic feet of stem wood, exclusive of bark, of BLACK ASH trees of different diameters and heights, 75 to 300 years in age; and factors to multiply by to reduce to cubic feet, including bark.*

Diameter breast-high.	Total height of tree—feet.						Factors to multiply by to reduce to cubic feet, including bark.	Basis.
	60	70	80	90	100	110		
	Peeled volume—cubic feet.							
Inches.								*Trees.*
6	5.4	6.3	7.2	.....	.....	.....	1.22	.....
7	7.3	8.5	9.7	.....	.....	.....	1.21	2
8	9.4	11.0	12.6	.....	.....	.....	1.21	4
9	11.9	13.9	15.8	.....	.....	.....	1.20	6
10	14.9	17.3	19.8	.....	.....	.....	1.20	8
11	17.8	21.0	24.0	.....	.....	.....	1.19	5
12	21.0	25.0	28.0	32	.....	.....	1.19	10
13	25.0	29.0	33.0	37	.....	.....	1.18	16
14	29.0	34.0	39.0	43	.....	.....	1.18	4
15	33.0	39.0	44.0	50	.....	.....	1.17	9
16	38.0	44.0	50.0	57	63	.....	1.17	12

TABLE 44.—*Volume in cubic feet of stem wood, exclusive of bark, of BLACK ASH trees of different diameters and height, 75 to 300 years in age, etc.*—Continued.

Diameter breast-high.	Total height of tree—feet.						Factors to multiply by to reduce to cubic feet, including bark.	Basis.
	60	70	80	90	100	110		
	Peeled volume—cubic feet.							
Inches.								*Trees.*
17	43.0	50.0	57.0	64	71	.....	1.16	4
18	48.0	56.0	64.0	72	80	.....	1.16	7
19	.....	62.0	71.0	80	89	.....	1.15	5
20	.....	69.0	78.0	88	98	108	1.15	3
21	.....	76.0	87.0	98	108	119	1.14	8
22	.....	83.0	95.0	107	119	131	1.14	2
23	.....	91.0	104.0	117	130	143	1.13	2
24	.....	99.0	113.0	127	141	155	1.13	1
25	.....	.....	123.0	138	153	169	1.12	2
26	.....	.....	133.0	149	166	183	1.12	1
27	.....	.....	143.0	161	179	197	1.12	2
28	.....	.....	154.0	173	193	212	1.11	1
29	.....	.....	165.0	186	207	227	1.11	1
30	.....	.....	177.0	199	221	243	1.11	1
								116

TABLE 45.—*Volume of stem in cords,*[1] *including bark, of BLACK ASH 75 to 300 years in age, for trees of different diameters and heights, and per cent of bark in trees of different diameters.*

[Based on taper table.]

Diameter breast-high.	Total height of tree—feet.						Bark.	Basis.
	60	70	80	90	100	110		
	Volume—cords.							
Inches.							*Per cent.*	*Trees.*
6	0.066	0.077	0.088	.....	.....	.....	18.0	.....
7	.088	.103	.117	.....	.....	.....	17.6	2
8	.114	.133	.152	.....	.....	.....	17.2	4
9	.143	.167	.190	.....	.....	.....	16.8	6
10	.179	.208	.238	.....	.....	.....	16.4	8
11	.212	.248	.283	.....	.....	.....	16.0	5
12	.253	.296	.338	0.381	.....	.....	15.7	10
13	.293	.342	.391	.440	.....	.....	15.3	16
14	.341	.398	.454	.511	.....	.....	14.9	4
15	.388	.453	.518	.583	.....	.....	14.5	9
16	.442	.516	.590	.663	0.737	.....	14.2	12
17	.495	.578	.660	.742	.825	.....	13.8	4
18	.554	.647	.739	.832	.923	.....	13.5	7
19	.....	.714	.815	.918	1.019	.....	13.1	5
20	.....	.790	.903	1.015	1.128	1.241	12.8	3
21	.....	.865	.990	1.113	1.236	1.360	12.4	8
22	.....	.948	1.083	1.219	1.354	1.490	12.1	2
23	.....	1.028	1.175	1.322	1.469	1.617	11.8	2
24	.....	1.118	1.277	1.437	1.597	1.756	11.4	1
25	.....	.....	1.375	1.547	1.718	1.891	11.1	2
26	.....	.....	1.487	1.673	1.859	2.046	10.8	1
27	.....	.....	1.605	1.805	2.006	2.206	10.5	2
28	.....	.....	1.711	1.924	2.138	2.352	10.2	1
29	.....	.....	1.834	2.063	2.293	2.582	9.9	1
30	.....	.....	1.962	2.208	2.453	2.697	9.6	1
								116

[1] To reduce to cubic feet, including stump, multiply the number of cords in each case by 100.

TABLE 46.—*Volume, in board feet, of BLACK ASH, 75 to 300 years in age, for trees of different diameters, and number of logs, scaled by the Scribner log rule.*

[Based on taper curves; scaled mostly as 16.3-foot logs, with a few shorter logs where necessary. Height of stump, 1 foot. Measurements taken in New Hampshire, New York, Michigan, and Indiana.]

Diameter breast-high.	Number of 16-foot logs.									Diameter inside bark of top.	Basis.
	2	2½	3	3½	4	4½	5	5½	6		
	Volume—board feet.										
Inches.										*Inches.*	*Trees.*
8	38	52	65	.....	.....	.....	.....	.....	.....	6	4
9	42	57	72	.....	.....	.....	.....	.....	.....	6	6
10	47	63	80	100	.....	.....	.....	.....	.....	6	8
11	53	70	99	120	.....	.....	.....	.....	.....	6	5
12	59	80	100	130	160	.....	.....	.....	.....	6	10
13	66	90	110	150	180	.....	.....	.....	.....	6	16
14	74	100	130	170	200	230	.....	.....	.....	6	4
15	83	110	150	190	230	260	.....	.....	.....	6	9
16	93	130	170	210	250	290	340	.....	.....	6	12
17	.....	140	190	240	280	330	370	.....	.....	6	4
18	.....	160	210	270	320	360	420	460	.....	6	7
19	.....	180	240	300	360	400	460	510	.....	6	5
20	.....	190	270	340	400	450	510	570	610	6	3
21	.....	.....	300	380	440	500	570	630	680	7	8
22	.....	.....	340	430	500	560	630	700	750	7	2
23	.....	.....	380	490	560	630	700	770	830	8	2
24	.....	.....	430	550	630	710	770	850	920	9	1
25	.....	.....	.....	620	700	790	860	940	1,020	9	2
26	.....	.....	.....	690	780	870	950	1,030	1,120	10	1
27	.....	.....	.....	770	860	960	1,040	1,130	1,220	10	2
28	.....	.....	.....	850	950	1,050	1,140	1,240	1,340	11	1
29	.....	.....	.....	930	1,040	1,140	1,240	1,350	1,450	11	1
30	.....	.....	.....	1,020	1,130	1,230	1,340	1,460	1,570	12	1
											114

TABLE 47.—*Yield of planted groves of GREEN ASH in South Dakota.*[1]

Locality.	Age of grove.	Average height of trees.	Area of plot.	Number of trees per acre.	Total yield per acre.	Average annual yield per acre.	Estimate of posts, stakes, and fuel wood.			
							First-class posts, 4-inch to 6-inch.	Second-class posts, 3-inch to 6-inch.	Stakes, 2-inch to 3-inch.	Fuel wood in addition.
	Years.	*Feet.*	*Acres.*		*Cords.*	*Cords.*	*Number.*	*Number.*	*Number.*	*Cords.*
Ethan	8	16	0.1	1,020	2.24	0.28	.....	.....	.....	.....
Wentworth	14	16	.5	508	2.18	.15	.....	.....	210	4.05
Lake Preston	14	20	.3	730	4.43	.32	.....	170	570	.66
Hamlin	14	22	.5	1,160	6.58	.47	.....	302	510	3.34
Olivet	18	25	.1	1,200	9.90	.55	.....	400	910	3.10
Sioux Falls	19	33	.5	238	9.62	.51	232	238	122	1.30
Do	20	30	.1	824	7.28	.36	170	170	590	2.40
Viborg	20	26	.1	1,140	7.50	.38	.....	310	850	2.30
Hartman	20	33	.2	400	6.55	.33	250	.....	545	.73
Lake Preston	20	26	.5	942	9.52	.48	.....	190	810	3.10
Dell Rapids	20	27	.1	680	7.90	.40	140	140	380	2.80
Hooker	22	27	.2	1,665	12.20	.55	.....	375	1,020	4.65
Lisle	23	24	.2	1,010	5.30	.23	.....	130	665	1.55
Canastata	23	18	.1	2,550	7.00	.30	.....	.....	660	3.90
Davis	25	23	.2	940	3.80	.15	.....	10	680	.90
Blackmer	25	29	.1	830	10.40	.42	.....	700	700	2.60
Cottonwood	34	47	.2	495	23.55	.69	870	645	600	1.50

[1] Based on average measurements taken in 1904 by Fetherolf.

TABLE 48.— *Yield of planted groves of GREEN ASH in Nebraska.*[1]

County.	Area of grove.	Age of grove.	Dominant trees.		Yield per acre.				
					Fuel wood.		Posts.		
			Average diameter breast high.	Number of trees per acre.	Total.	Average annual.	Firsts.	Seconds.	Total.
	Acres.	*Years.*	*Inches.*		*Cords.*	*Cords.*	*Number.*	*Number.*	*Number.*
Jefferson	1.30	17	3.1	540	3.2	0.2	.....	35	35
Washington	2.50	17	4.7	1,083	15.4	.9	310	430	740
Nemaha	1.00	18	3.7	1,054	18.4	1.0	442	494	936
Polk	.92	19	4.2	965	9.8	.5	130	365	495
Colfax	1.50	19	2.9	844	6.1	.3	28	172	200
Hall	2.50	20	2.4	1,304	8.4	.4	20	28	48
Clay	3.43	20	4.2	1,446	11.2	.6	30	232	262
Otoe	3.00	21	4.5	744	11.8	.6	290	464	754
Hamilton	2.50	21	4.2	932	11.8	.6	167	312	488
York	7.00	21	4.2	714	11.7	.6	288	502	790
Fillmore	.99	21	3.7	928	11.3	.5	218	294	512
Polk	1.20	21	4.9	725	14.7	.7	300	317	617
Kearney	1.04	21	6.2	805	18.7	.9	702	504	1,206
Richardson	.80	21	4.3	1,192	24.0	1.1	1,072	584	1,656
Johnson	.95	22	5.1	492	7.4	.3	228	312	540
Saunders	1.56	22	4.8	446	7.5	.3	138	188	326
Hamilton	1.10	23	5.3	496	15.6	.7	294	280	574
York	1.70	23	4.7	835	17.3	.8	425	410	835
Webster	6.60	25	3.8	517	4.0	.2	51	155	206
Fillmore	4.24	25	5.7	345	12.4	.5	190	111	301
Lancaster	.48	25	5.3	497	14.8	.6	327	240	567
Polk	3.10	27	6.2	309	11.6	.4	441	208	649
Butler	.38	29	4.9	950	20.1	.7	490	480	970
Clay	5.30	30	5.8	352	10.0	.3	246	184	430
Saunders	1.50	30	6.1	368	19.3	.6	1,068	370	1,438
Do	1.10	30	7.4	236	26.4	.9	1,162	486	1,648
Do	1.50	32	4.6	553	12.9	.4	343	330	673
Cuming	.25	33	4.6	530	14.8	.5	465	420	885
Saunders	3.10	33	7.0	383	18.9	.6	1,040	420	1,640

[1] From Circular 45 of the Forest Service.

TABLE 49.— *Yield of GREEN ASH plantations in the Plains States.*[1]

Age.	Height.	Total value of posts.	Value of post per acre per annum.		Firsts and seconds.	Trees per acre.
			Without interest on the investment.	4 per cent interest on the investment.		
Years.	*Feet.*				*Per cent.*	*Number.*
19	28	$147.10	$7.74	$5.32	25.5	1,000
23	30	272.50	11.85	7.44	39.3	1,274
23	22	137.20	5.97	3.75	41.6	908
25	49	270.90	10.84	6.51	49.7	680
35	25	135.00	3.86	1.83	42.7	436
40	53	240.45	6.01	2.53	67.5	500
40	45	250.60	6.26	2.64	70.5	535

[1] From Bulletin 86 of the Forest Service, by Carlos G. Bates.

NOTE.—The following conclusions were drawn from the above table: (1) Highest financial returns in 25 years. (2) Ash posts of best quality only at much greater age. (3) Best posts with closest spacing; without this, trees crooked, branchy, and knotty. (4) Should not be planted on dry sites, as the growth is too retarded.